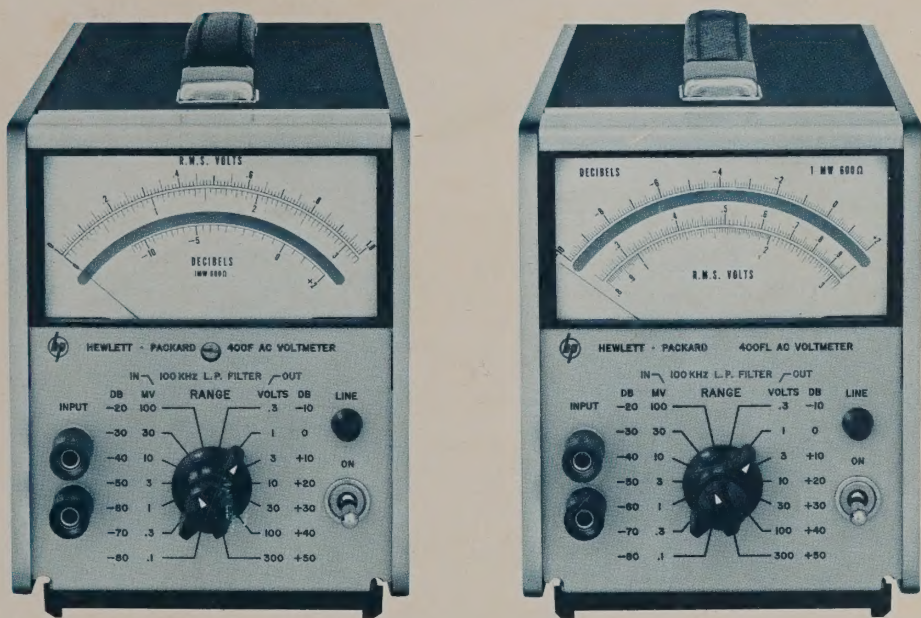
HP 400 F/FL

OPERATING AND SERVICE MANUAL

AC VOLTMETER

400F/FL



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HP 400 F/FL

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CERTIFICATION

The Hewlett-Packard Company certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory. The Hewlett-Packard Company further certifies that its calibration measurements are traceable to the U.S. National Bureau of Standards to the extent allowed by the Bureau's calibration facility.

WARRANTY AND ASSISTANCE

All Hewlett-Packard products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products which prove to be defective during the warranty period provided they are returned to Hewlett-Packard. No other warranty is expressed or implied. We are not liable for consequential damages.

Service contracts or customer assistance agreements are available for Hewlett-Packard products that require maintenance and repair on-site.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

OPERATING AND SERVICE MANUAL

(HP PART NO. 00400-90009)

MODEL 400F/FL AC VOLTMETER

SERIALS PREFIXED: 950-

Appendix C, Manual Backdating Changes, adapts this manual to serials prefixed 617-, 734-, 912-.

P. O. Box 301, Loveland, Colorado, 80537 U. S. A.

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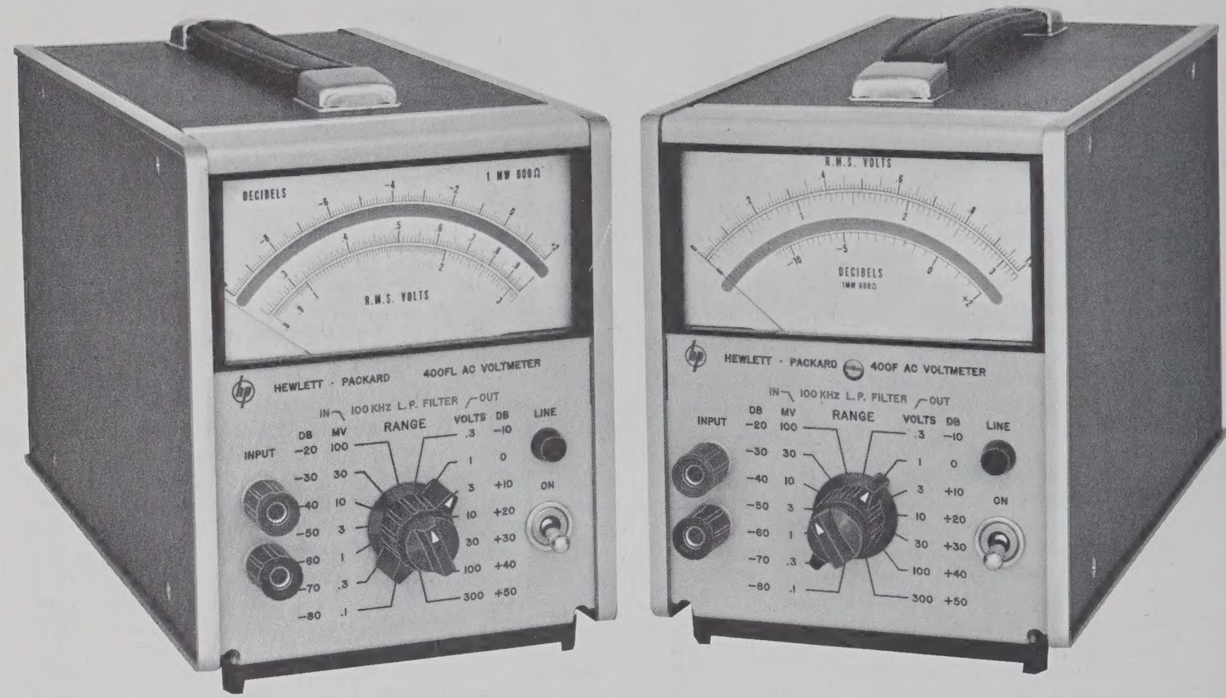


Figure 1-1. Model 400F/FL AC Voltmeter

Table 1-1. Specifications

Voltage Range: 100 μV to 300 V full scale, 14 ranges in 1, 3, 10 sequence.

Frequency Range: 20 Hz to 4 MHz.

Calibration: Responds to absolute average value of applied signal, calibrated in rms volts.

Noise Referred to Input: (1000 ohm termination)

RANGE	Filter In	Filter Out
300 μV to 300 V	< 5 μV	< 30 μV
100 μV	< 5 μV	< 15 μV

Note: Noise adds to the signal approximately according to the relation:

$$\text{Reading} = \sqrt{(\text{signal})^2 + (\text{noise})^2}$$

Input Impedance: 10 megohms shunted by < 30 pF on the 100 μV - 300 mV ranges and 10 megohms shunted by < 15 pF on the 1 V - 300 V ranges.

Amplifier AC Output: 1 V rms, open circuit, for full scale indication; output impedance 600 Ω, Frequency Response 20 Hz to 4 MHz on 1 mV to 300 V ranges. 30 Hz to 100 kHz on 100 μV and 300 μV range, 100 kHz filter in the "in" position on the 100 μV and 300 μV range.

Meter Response: < 1 second after application of signal.

Recovery From Overload: < 2 seconds for 80 dB overload.

AC Power: 115 or 230 volts ±10%, 50 Hz to 400 Hz, 5 watts.

External Battery Operation: Terminals are provided on rear panel; positive and negative voltages between 35 V and 55 V are required. Current drain from each voltage is approximately 45 mA.

Temperature Range: 0 to +55°C.

Weight:

Net: 6 lbs. (2, 7 kg).

Shipping: 9 lbs. (4 kg).

Dimensions: 6-1/2" high, 5-1/8" wide, 11" deep (165, 1 x 130, 2 x 279, 4 mm).

SECTION I
GENERAL INFORMATION

1-1. DESCRIPTION.

1-2. The -hp- Models 400F and 400FL are versatile ac voltmeters and dB meters. Both models can be used as wideband amplifiers. The Model 400F is primarily intended for voltage measurements, whereas the Model 400FL is primarily a dB meter. However, both meters indicate both volts and dB. The 400F has a linear ac scale with a logarithmic dB scale underneath, and the 400FL has a linear dB scale with a logarithmic ac scale underneath. Since the difference in scales is the only difference between the two instruments, this manual will use the term 400F/FL in reference to both instruments.

1-3. Figure 1-1 shows both the Model 400F and the Model 400FL. Table 1-1 is a list of specifications.

1-4. OPTION (400F ONLY).

1-5. Option 01 is a standard -hp- Model 400F AC Voltmeter which has a dB scale that reads from -15 to +2 instead of from -12 to +2. The dB scale is placed at the top of the meter face for better resolution.

1-6. INSTRUMENT AND MANUAL IDENTIFATION.

1-7. Hewlett-Packard instruments are identified by a two-section, eight-digit serial number (000-00000). If the first three digits of the serial number on your instrument do not agree with those on the title page of this manual, change sheets supplied with the manual will define differences between your instrument and the Model 400F/FL described in this manual.

1-8. If a letter prefixes the serial number, the instrument was manufactured outside the United States.

1-9. BACKDATING INFORMATION.

1-10. Appendix C contains backdating information that adapts this manual to instruments with serials prefixed 617, 734, and 912.

Table 1-1. Specifications (Cont'd)

MODEL 400F ONLY
Accuracy: ± (% Full Scale + % Reading)

300 μV TO 300 V RANGES

Frequency: 20 Hz, 40 Hz, 100 Hz, 1 MHz, 2 MHz, 4 MHz

±(2 + 2)	±(1 + 1)	± (1/2 + 1/2)	± (1 + 1)	± (2 + 2)

100 μV RANGE

Frequency: 30 Hz, 60 Hz, 100 kHz, 500 kHz

± (2 + 2)	±(1 + 1)	$\pm\left(1 \begin{smallmatrix}+0\\-7\end{smallmatrix}\right)$

MODEL 400FL ONLY
Accuracy: ± % Reading

300 μV TO 300 V RANGES

Frequency: 20 Hz, 40 Hz, 100 Hz, 1 MHz, 2 MHz, 4 MHz

±4	±2	±1	±2	±4

100 μV RANGE

Frequency: 30 Hz, 60 Hz, 100 kHz, 500 kHz

±4	±2	+1 -8

SECTION II
INSTALLATION

2-1. INTRODUCTION.

2-2. This section contains information and instructions necessary for the installation and shipping of the Model 400F and 400FL voltmeters. Included are initial inspection procedures, power and grounding requirements, installation information, and instructions for repackaging for shipment.

2-3. INITIAL INSPECTION.

2-4. This instrument was carefully inspected both mechanically and electrically before shipment. It should be physically free of mars or scratches and in perfect electrical order upon receipt. To confirm this, the instrument should be inspected for physical damage in transit. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outlined in Paragraph 5-5. If there is damage or deficiency, see the warranty on the inside front cover of this manual.

2-5. POWER REQUIREMENTS.

2-6. The Model 400F/FL can be operated from any source of 115 or 230 volts at 50 to 1000 cycles or from two 35 to 55 volt batteries connected to the rear panel BATTERY terminals. The 115/230 V slide switch on the rear panel selects the desired line voltage. Power dissipation is 5 watts maximum.

2-7. GROUNDING REQUIREMENTS.

2-8. To protect operating personnel, the National Electrical Manufacturers' Association (NEMA) recommends that the instrument panel and cabinet be grounded. All Hewlett-Packard instruments are equipped with a three-conductor power cable which, when plugged into an appropriate receptacle, grounds the instrument. The offset pin on the power cable three-prong connector is the ground wire.

2-9. To preserve the protection feature when operating the instrument from a two-contact outlet, use a three-prong to two-prong adapter and connect the green pigtail on the adapter to ground.

2-10. INSTALLATION.

2-11. The Model 400F/FL is fully transistorized; therefore, no special cooling is required. However, the instrument should not be operated where the ambient temperature exceeds 55°C (131°F) or the relative humidity exceeds 95%.

2-12. <u>BENCH MOUNTING.</u>

2-13. The Model 400F/FL is shipped with plastic feet and tilt stand in place, ready for use as a bench instrument.

2-14. <u>RACK MOUNTING.</u>

2-15. The Model 400F/FL may be rack mounted by using an adapter frame (-hp- Part No. 5060-0797). The adapter frame is a rack frame that accepts any combination of submodular units. It can be rack mounted only. For additional information, address inquires to your -hp- Sales and Service Office. (See Appendix B for office locations.)

2-16. <u>COMBINATION MOUNTING.</u>

2-17. The Model 400F/FL may be mounted in combination with other submodular units by using a Combining Case (-hp- Model 1051A or 1052A). The Combining Case is a full-module unit which accepts various combinations of submodular units. Being a full-module unit, it can be bench or rack mounted and is analogous to any full-module instrument.

2-18. REPACKAGING FOR SHIPMENT.

2-19. The following paragraphs contain a general guide for repackaging of the instrument for shipment. Refer to Paragraph 2-20 if the original container is to be used; 2-21 if it is not. If you have any questions, contact your local -hp- Sales and Service Office. (See Appendix B for office locations.)

NOTE

If the instrument is to be shipped to Hewlett-Packard for service or repair, attach a tag to the instrument identifying the owner and indicating the service or repair to be accomplished; include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number, serial number, and serial number prefix.

2-20. If original container is to be used, proceed as follows:

a. Place instrument in original container if available. If original container is not available, one can be purchased from your nearest -hp- Sales and Service Office.

b. Ensure that container is well sealed with strong tape or metal bands.

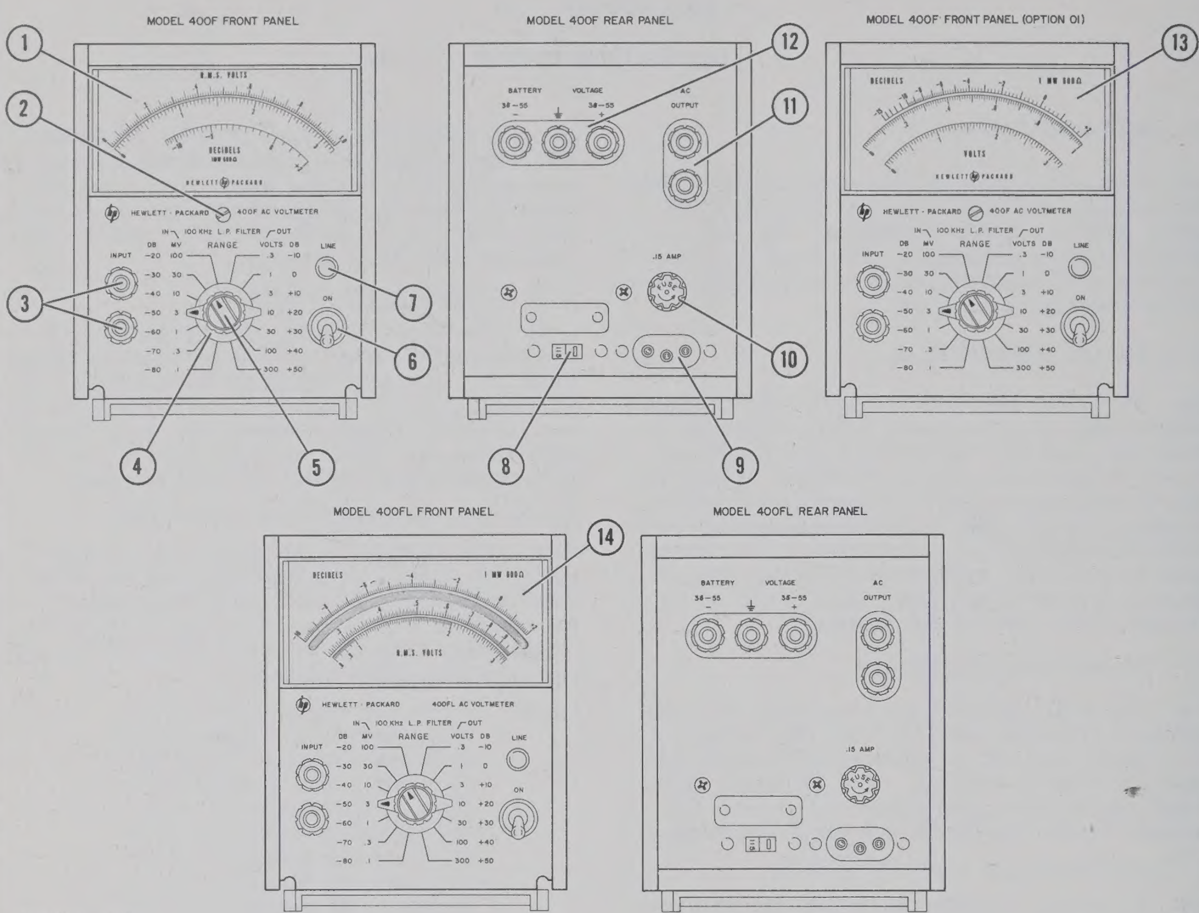
2-21. If original container is not to be used, proceed as follows:

a. Wrap instrument in heavy paper or plastic before placing in an inner container.

b. Place packing material around all sides of instrument and protect panel face with cardboard strips.

c. Place instrument and inner container in a heavy carton or wooden box and seal with strong tape or metal bands.

d. Mark shipping container with "DELICATE INSTRUMENT", "FRAGILE" etc.



400F/FL-B-0639A

(1) 400F Scale: Indicates magnitude of applied signal in volts and dBm.

(2) Mechanical Zero Adjust: Provides a mechanical meter zero adjustment.

(3) INPUT Terminals: Connects signal to be measured to 400F/FL.

(4) RANGE Selector (S1): Selects full scale reading of meter. DBm reading on scale adds algebraically to dB setting of RANGE selector.

(5) 100 KHz LP FILTER Switch (S2): Switches 100 KHz filter either in or out of circuit.

(6) Line ON Toggle Switch (S3): Applies primary power.

(7) LINE Indicator Lamp: Indicates application of primary power.

(8) 115/230 Volt Slide Switch (S4): Selects 115 or 230 volts ac for line operation.

(9) Primary Power Connector: Line voltage is applied through this connector.

(10) FUSE: Protects instrument against current overload.

(11) AC OUTPUT: Ac amplifier output. Output impedance is 600 Ω.

(12) BATTERY VOLTAGE Terminals: 400F/FL may be powered by connecting two 35 to 55 volt batteries to these terminals.

(13) 400F Scale, Option 01: The dBm scale is placed uppermost for greater resolution.

(14) 400FL Scale: Indicates magnitude of applied signal in volts and dBm. DBm scale is linear, and voltage scales are logarithmic. This arrangement allows better resolution for dB reading. 0 dBm = 1 mW in 600 Ω.

Figure 3-1. Location of Controls and Indicators

SECTION III
OPERATING INSTRUCTIONS

3-1. INTRODUCTION.

3-2. This section contains instructions and information necessary for the operation of the 400F/FL AC Voltmeters. Included is identification of controls, indicators and connectors, turn on procedures, and operating instructions.

3-3. CONTROLS, INDICATORS AND CONNECTORS.

3-4. Each control, indicator, and connector on the 400F/FL is identified and described in Figure 3-1.

3-5. METER MECHANICAL ZERO ADJUSTMENT (400F ONLY).

3-6. The mechanical zero adjustment is located in the center of the instrument front panel. If the meter pointer does not indicate zero after the instrument has been off at least one minute, mechanically zero the meter, following the steps outlined below.

a. Turn instrument power off, and allow at least one minute for meter pointer to stabilize.

b. Rotate zero adjustment screw clockwise until pointer is left of zero and moving upscale.

c. Continue rotating screw clockwise until pointer is at zero. Stop when pointer is exactly on zero. If pointer overshoots, repeat step b.

d. When pointer is exactly over zero, rotate adjustment screw slightly counterclockwise to relieve tension on pointer suspension. If pointer moves to the left, repeat whole procedure, but make counterclockwise rotation less.

3-7. TURN ON PROCEDURES.

a. If line voltage is used, ensure that the 115-230 vac switch (located on the rear panel) is in the correct position. Turn the line ON toggle switch to the ON position. The LINE lamp will glow, indicating that line power is applied.

b. If batteries are used, connect two 35 to 55 volt batteries as shown in Figure 3-2. The line ON switch is not in the circuit when batteries are used, therefore an external DPST switch should be used to provide a means for disconnecting the batteries when the instrument is not in use.

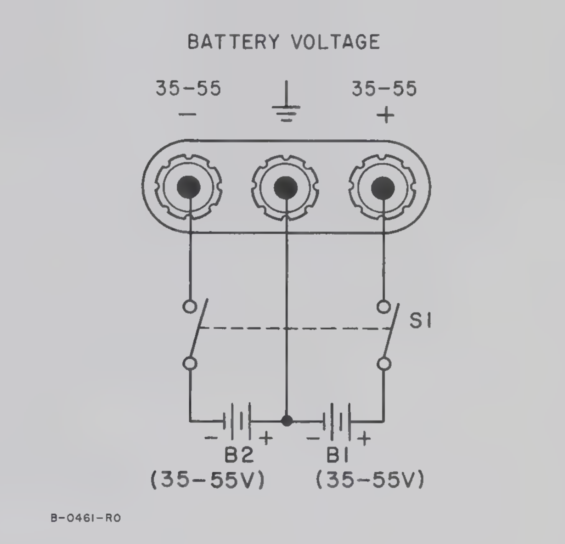


Figure 3-2. External Battery Connection

3-8. AC VOLTAGE MEASUREMENTS.

NOTE

Since the 400F/FL is average responding and rms calibrated, any distortion will affect the accuracy of the measurement. Table 3-1 shows the errors caused by distortions.

Table 3-1. Effect of Distortion on Average Responding Meter

HARMONIC	% DISTORTION	% ERROR (* Fundamental)	
		MAX. POSITIVE	MAX. NEGATIVE
Any even	0.1	0.000	
	0.5	0.001	
	1.0	0.005	
	2.0	0.020	
Third	0.1	0.033	0.033
	0.5	0.168	0.167
	1.0	0.338	0.328
	2.0	0.687	0.667
Fifth	0.1	0.020	0.020
	0.5	0.101	0.099
	1.0	0.205	0.195
	2.0	0.420	0.380

*Depends on phase relationship between harmonic and fundamental.

a. Perform the steps listed under Paragraphs 3-5 and 3-7.

b. Set the meter RANGE switch to the approximate range of the voltage to be measured.

CAUTION

DO NOT APPLY MORE THAN 600 VOLTS TO INPUT. DO NOT OVERLOAD THE .1 MV THROUGH .3 VOLT RANGES WITH MORE THAN 300 VOLTS AT FREQUENCIES BELOW 300 kHz OR WITH MORE THAN 64 VOLTS AT FREQUENCIES ABOVE 300 kHz. IF ANY OF THESE OVERLOADS ARE EXCEEDED, THE INSTRUMENT MAY BE DAMAGED.

c. If the signal to be measured is a frequency less than 100 kHz, the 100 kHz L. P. FILTER may be switched in to filter out all frequency components above 100 kHz.

d. Connect the signal to be measured to the INPUT terminals. The RMS voltage amplitude of the input will be indicated on the meter.

3-9. DB MEASUREMENTS.

a. Perform the steps listed under Paragraphs 3-5 and 3-7.

b. The dB measurement is equal to the algebraic sum of the meter indication and the RANGE setting. For example: if the RANGE setting is +20 dB, and the meter reading is -3 dB, the actual dB measurement is +17 dB.

c. The dB scale of the 400F/FL is calibrated in dBm. 0 dBm is equivalent to 1 milliwatt dissipated by a 600 ohm load. Therefore, all measurements in dBm must be made across a total impedance of 600 ohms. Measurements across all other impedances will be in dB, but not in dBm.

d. A reading in dB may be converted to dBm by using the Impedance Correction Graph (Figure 3-3). For example: to convert a 40 dB reading across 100 ohms to dBm, locate the 100 ohm load impedance on the bottom of the graph. Follow the impedance line to the heavy black line, and read the meter correction at that point. The correction for 100 ohms is +7.5 dBm, and the corrected reading is +47.5 dBm.

3-10. WIDE BAND AC AMPLIFIER.

CAUTION

EXTREME CARE SHOULD BE TAKEN TO AVOID COMMON GROUND PATHS BETWEEN THE INPUT AND OUTPUT SIGNALS. BECAUSE OF THE HIGH GAIN OF THE INSTRUMENT ON THE MORE SENSITIVE RANGES (80 DB ON .1 MV RANGE, ETC.), COMMON GROUND PATHS CAN CAUSE OSCILLATIONS AT HIGHER FREQUENCIES.

a. Perform the steps listed in Paragraphs 3-5 and 3-7.

b. Set the meter RANGE switch to the approximate range of the input signal.

c. When signals of frequencies less than 100 kHz are being amplified, the 100 kHz, L. P. FILTER may be switched in to reduce high frequency noise and lessen the possibility of oscillations.

d. Connect the input signal to the INPUT terminals.

e. Table 3-2 shows the gain factor for each range of the 400F/FL into an open circuit.

Table 3-2. AC Amplifier Gain Factors

RANGE	GAIN	RANGE	GAIN
300 V	-50 dB	100 mV	+20 dB
100 V	-40 dB	30 mV	+30 dB
30 V	-30 dB	10 mV	+40 dB
10 V	-20 dB	3 mV	+50 dB
3 V	-10 dB	1 mV	+60 dB
1 V	0 dB	.3 mV	+70 dB
.3 V	+10 dB	.1 mV	+80 dB

3-11. 400F WITH OPTION 01.

3-12. Operating procedures for the 400F with Option 01 are the same as the operating procedures for the standard 400F. The only difference between the two models is the scale layout. The 400F with Option 01 has a dB scale which reads from -15 to +2, instead of from -12 to +2. The dB scale is placed at the top of the meter face for better resolution.

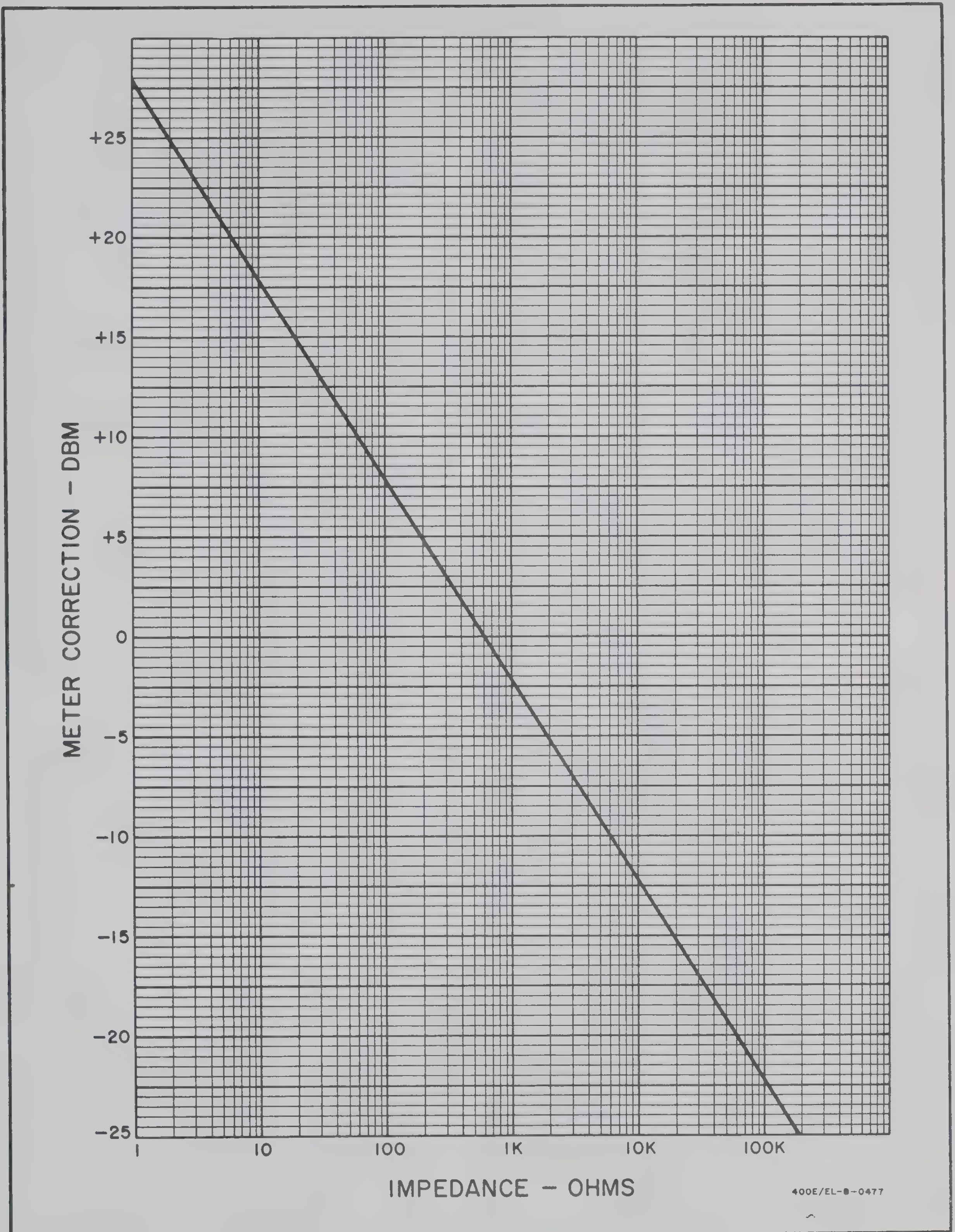


Figure 3-3. Impedance Correction Graph

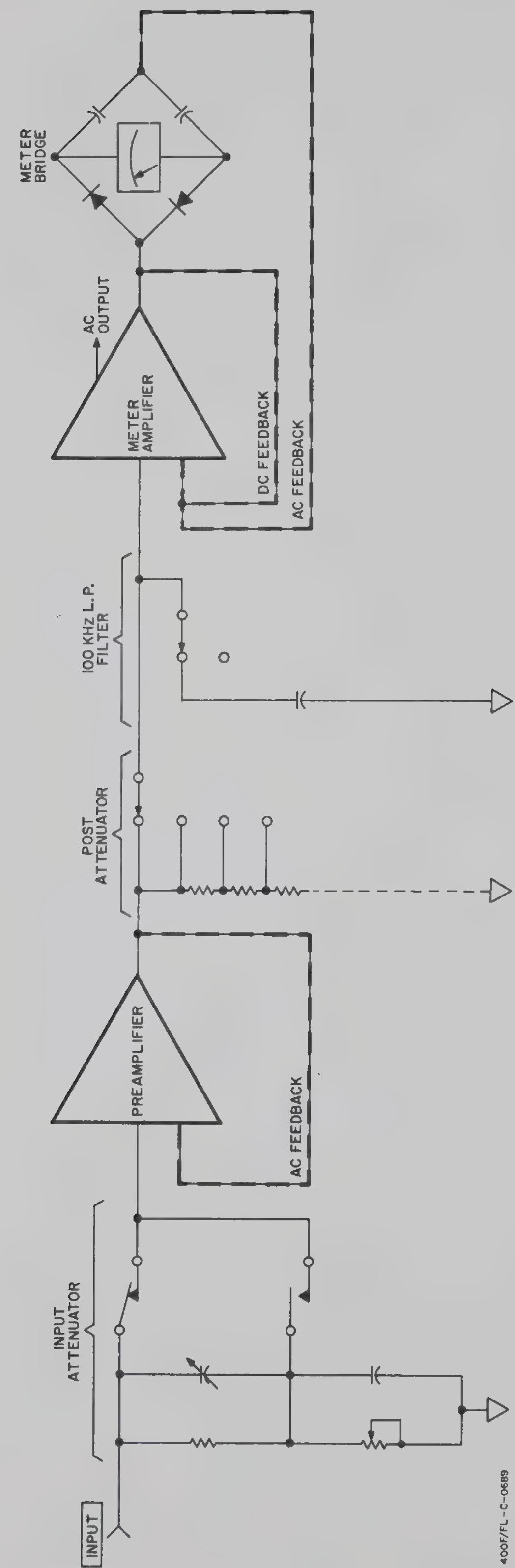


Figure 4-1. Functional Circuit Diagram

SECTION IV
THEORY OF OPERATION

4-1. GENERAL.

4-2. The 400F/FL is a solid state, average responding, rms calibrated ac voltmeter. It may also be used as a wide band ac amplifier, with switchable gain and switchable bandwidth. Refer to Figure 4-1 for a functional circuit diagram of the instrument.

4-3. BLOCK DIAGRAM DESCRIPTION.

4-4. The voltage to be measured is applied to the input attenuator, where it is either attenuated by 60 dB, or coupled directly to the preamplifier. The preamplifier provides 10 dB of gain for the input signal and applies it to the post attenuator. The signal goes from the post attenuator to the 100 KHz LOW PASS filter, which may be switched in to limit the bandwidth to signals from 20 Hz to 100 KHz. The meter amplifier then amplifies the signal, couples it to the meter bridge, and supplies a signal to the AC OUTPUT terminal. The meter bridge rectifies the ac signal and applies it to meter M1, which indicates the rms value of the input voltage. The meter bridge also provides the ac feedback to the meter amplifier.

4-5. SCHEMATIC THEORY.

4-6. Refer to Figure 6-3 for the following discussion.

4-7. INPUT ATTENUATOR.

4-8. The input attenuator consists of an rc voltage divider and two reed relays. On the .1 mV through .3 V ranges, reed relay A1K1 is energized by -26 V from wafer (A) of the RANGE switch, S1, routing the input signal directly to the preamplifier. On all other ranges, the -26 V is applied to relay A1K2. When A1K2 is closed, the input signal is attenuated 60 dB by the rc divider and coupled to the preamplifier.

4-9. PREAMPLIFIER.

4-10. The preamplifier is a three stage ac amplifier that amplifies the signal from the input attenuator by 10 dB. It also functions as an impedance matcher to match the high impedance of the input attenuator to the much lower impedance of the post attenuator.

4-11. Capacitor A2C5 blocks dc transients and couples the ac signal to the preamplifier. The input signal is limited to 5.4 volts peak-to-peak by diodes A2CR2 and A2CR4, which are biased at 2.7 V and 2.7 V respectively, by zener diodes A2CR1 and A2CR5. A field effect transistor, A2Q1, is used as the input stage of the preamplifier because of its low noise characteristics and high input impedance. The signal is taken from the drain of A2Q1 and is further amplified by A2Q2 and A2Q3.

4-12. Feedback from the emitter of A2Q2 bootstraps the value of A2R9, the drain load of A2Q1. Feedback from the source of A2Q1 bootstraps the input impedance of the preamplifier and keeps it at a high level over all ranges of inputs. Gain stability and linearity of the preamplifier are maintained by feedback from the collector of A2Q2 and the emitter of A2Q3. A2R6 provides a bias adjustment for the field effect transistor, A2Q1.

4-13. POST ATTENUATOR.

4-14. The post attenuator is a precision resistive voltage divider that operates as a function of the RANGE switch. On the two lowest voltage ranges, the signal from the preamplifier is applied through two resistors (S1R1 and S1R15) to the 100 KHz LP FILTER and receives no attenuation. Six precision resistive divider circuits provide signal attenuation in progressive steps of 10 dB for the twelve higher ranges.

4-15. 100 KHz LOW PASS FILTER.

4-16. The 100 KHz LP FILTER is a 0.01 μF capacitor (S1C1) which may be switched into or out of the circuit by switch S2. When the filter is in the circuit, the bandwidth of the instrument is from 20 Hz to 100 KHz. If the filter is switched out of the circuit, the bandwidth is increased to 4 MHz. Refer to Figure 4-2 for a graph of the filter attenuation characteristics.

Figure 4-2. Filter Attenuation Characteristics

4-17. METER AMPLIFIER.

4-18. The meter amplifier is a four stage, direct coupled voltage and power amplifier. The first stage is a differential amplifier, A2Q10 and A2Q12, which amplifies the difference between the input signal and the feedback signal on the base of A2Q12, the feedback summing junction. The three other stages of amplification are provided by A2Q11, A2Q13, and A2Q15.

4-19. AC feedback from the meter bridge to the feedback summing junction is adjustable at 4 MHz (A2C36) and 400 Hz (A2R62) on the 30 mV range. On the .1 mV range, A2R64, A2R67, and A2R68 are switched into the circuit to increase the gain of the amplifier by 10 dB and to allow a 400 Hz gain adjustment to be made.

4-20. DC feedback from the collector of A2Q15 to the feedback summing junction is adjustable at 20 Hz (A2R59) on the 30 mv range. A2R58 is switched into the circuit on the .1mV range to provide a feedback adjustment at 30 Hz. These adjustments provide overall amplifier gain stability for the entire voltage and frequency range of the instrument.

4-21. A2Q14 isolates the AC OUTPUT circuit from the meter amplifier and the meter bridge. It is an independent current source which will supply a signal to the OUTPUT terminal that is identical to the signal applied to the meter bridge. That is, for a 1 V rms signal for full scale meter deflection, A2Q14 will provide a 1 V rms signal at the AC OUTPUT terminal.

4-22. METER BRIDGE.

4-23. Refer to Figure 4-3 for a simplified diagram of the metering circuit.

4-24. The meter bridge is a full wave rectifier that converts the ac signal from the meter amplifier into dc. It supplies current to drive the meter and provides an ac feedback signal to the meter amplifier.

4-25. Transistor A2Q16 provides a large output impedance for the meter amplifier, and is the current drive source for the meter bridge circuit. The collector output of A2Q16 is applied to the meter bridge, and is rectified by diodes A2CR22 and A2CR23. The ac components of the bridge signal are coupled into the feedback loop by capacitors A2C38 and A2C39. A2Q17 bootstraps the resistance of A2R69 to a high value, so that current is driven through the bridge, keeping the meter circuit response linear to large variations in signal amplitude.

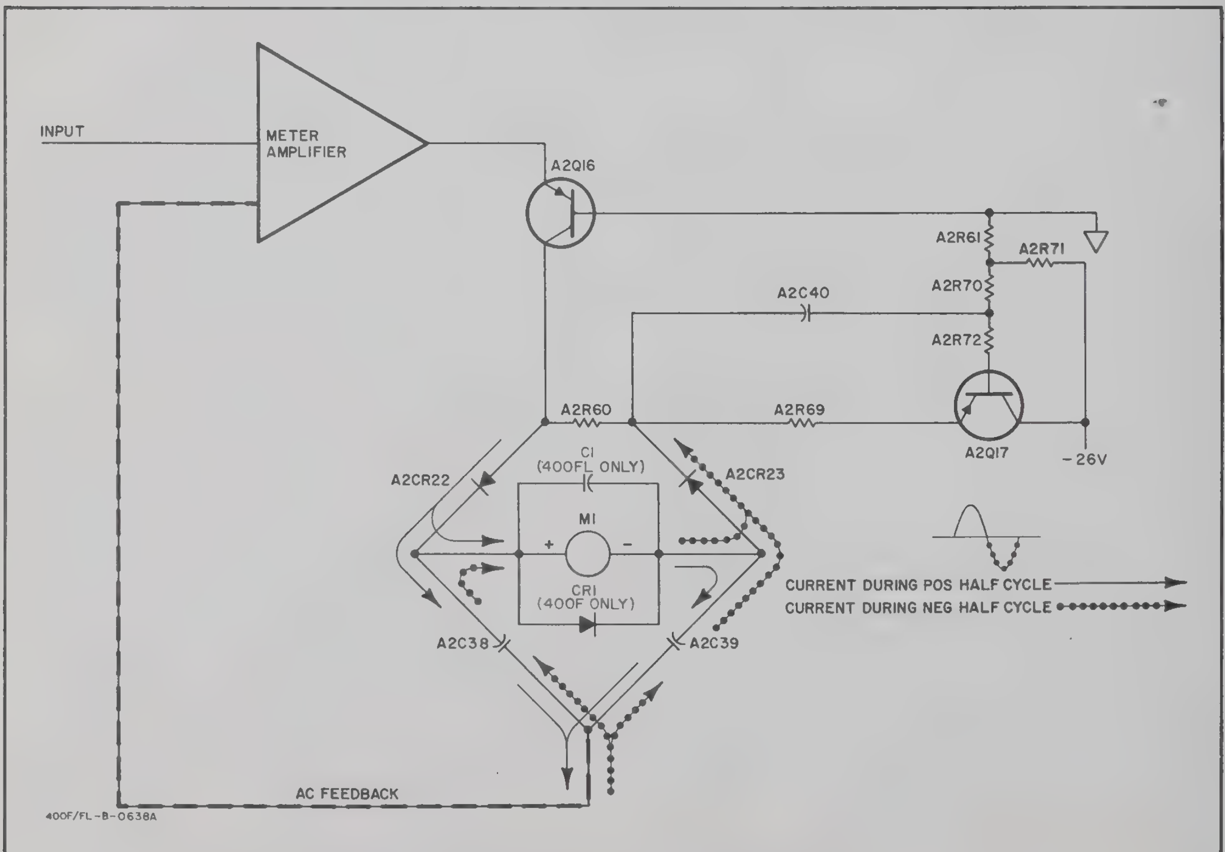


Figure 4-3. Simplified Diagram of Metering Circuit

4-26. The meter, M1, is a current driven device that utilizes a taut-band movement. It responds to the average value of the rectified meter amplifier output, which is proportional to the rms value of the sinusoidal signal being measured. The meter indicates the rms value of the input voltage and the power level in dBm for resistive loads of 600 ohms. Measurements across loads other than 600 ohms will be indicated in dB, but not dBm. The meter is protected from circuit overloads by diode CR1 (400F) and capacitor C1 (400FL).

4-27. POWER SUPPLY.

4-28. The power supply provides both a positive and negative 26 regulated output. It may be operated by external batteries (+35 V to 55 V and -35 V to 55 V) or line power (115 V or 230 V, 50 Hz to 1000 Hz).

4-29. The line input is converted to dc by a diode rectifier network consisting of A2CR6 through A2CR9. The positive output of the rectifier is applied to series regulator A2Q4, which regulates the +26 V supply. Control transistor A2Q6 has a constant emitter reference voltage supplied by zener diode A2CR13. Capacitor A2C16 couples any change in the +26 V output to the base of A2Q6, which will supply a signal proportional to the change in output voltage to A2Q5. A2Q5 will then amplify the signal and couple it to the base of the regulator A2Q4, causing it to regulate the output by either increasing or decreasing conduction.

4-30. The -26 V supply is regulated in the same manner, the only difference being that the control transistor A2Q7 is referenced to the +26 V output, instead of the zener diode.

Table 5-1. Test Equipment

INSTRUMENT TYPE	REQUIRED CHARACTERISTICS	USE	RECOMMENDED MODEL
AC Voltmeter Calibrator	Accuracy: 0.2% at 400 Hz Range: 30 mV to 1 V	Performance Checks and Calibration	-hp- Model 738BR Voltmeter Calibrator
Test Oscillator	Output: 30 mV to 1 V Frequency Range: 20 Hz to 4 MHz Distortion: < 1% Flatness: ±0.25%	Performance Checks and Calibration	-hp- Model 652A Test Oscillator or Combination -hp- Model 739AR Frequency Response Test Set and -hp- Model 200SR Oscillator
AC/DC Voltmeter/Ohmmeter	Volts Accuracy: 2% Ohms Accuracy: 5%	Troubleshooting	-hp- Model 427A Voltmeter
Termination	Feedthrough: 50 ohm impedance	Performance Checks and Calibration	-hp- Model 11048B
Resistor	Fxd, 100 kΩ ±1%	Performance Checks	-hp- Part No. 0757-0465
Resistor	Fxd, 1 kΩ ±1%	Performance Checks	-hp- Part No. 0757-0338
Crystal Socket (with terminals shorted)	Size: 1/2 inch	Performance Checks and Calibration (Shorting Test Points)	-hp- Part No. 1200-0028

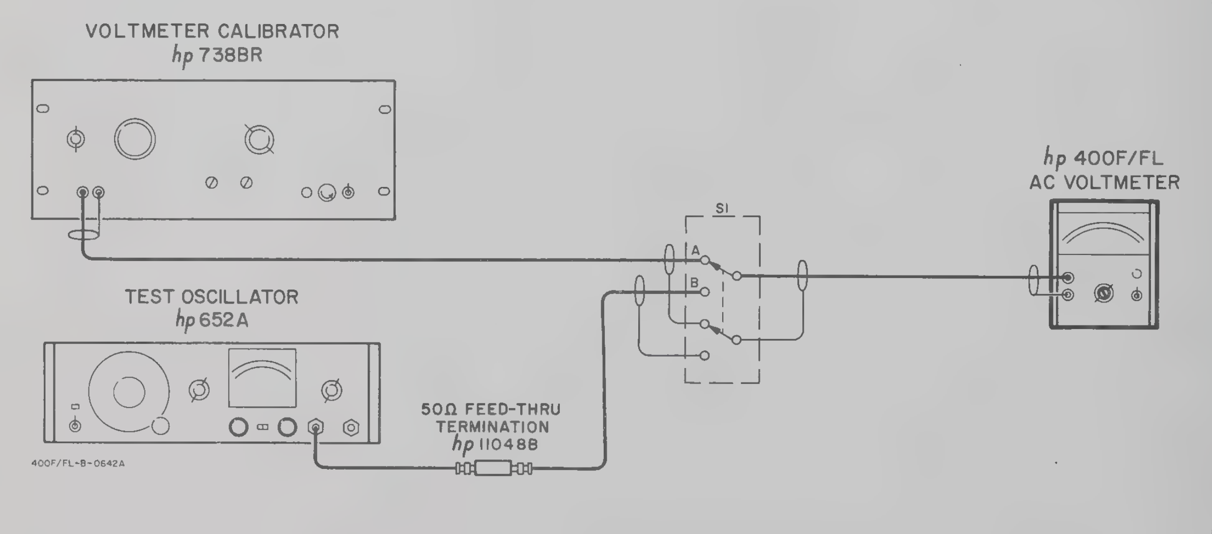


Figure 5-1. Accuracy and Frequency Response Check Setup

SECTION V
MAINTENANCE

5-1. INTRODUCTION.

5-2. This section contains maintenance and service information for the Model 400F/FL AC Voltmeter. Included are Performance Checks, Alignment and Calibration Procedures, and Troubleshooting Procedures.

5-3. TEST EQUIPMENT REQUIRED.

5-4. The equipment required to properly maintain the 400F/FL is listed in Table 5-1. The table lists the type of equipment to be used, the specification requirements, and the recommended commercially available test equipment.

NOTE (400F only)

Before beginning the Performance Checks, mechanically zero the meter according to the procedures in Paragraph 3-5.

5-5. PERFORMANCE CHECKS.

5-6. The following Performance Checks compare the Model 400F/FL with its accuracy specifications (Table 1-1). These checks may be used for incoming inspection, periodic maintenance, and for specification checks after a repair. A Performance Check Test Card is provided at the end of this section for recording the performance of the Model 400F/FL during the Performance Checks. The card can be removed from the manual and used as a permanent record of the incoming inspection or of a routine performance check.

5-7. A highly accurate and stable voltage reference that is variable from 20 Hz to 4 MHz is required for the Performance Checks. The -hp- Model 738BR Voltmeter Calibrator produces a 400 Hz signal that is within less than 0.2% of the indicated output. The -hp- Model 652A Test Oscillator can be referenced to the output of the Voltmeter Calibrator and can be adjusted to within 0.25% of the set reference voltage from 20 Hz to 4 MHz.

5-8. If the -hp- 652A Test Oscillator is not available, the 739AR Frequency Response Test Set and 200SR Oscillator combination may be used. This combination can be adjusted to within 0.5% of a set voltage reference from 20 Hz to 4 MHz. (The -hp- 739AR, -hp- 200SR, and -hp- 738BR are available in a rack mounted configuration designated -hp- K02-738BR VTVM Calibration System.)

5-9. The following procedures specify the use of the -hp- 652A and the -hp- 738BR. If the K02-738BR calibration system is used, follow the same general procedures.

5-10. Figure 5-1 shows the test setup for using the -hp- 652A and -hp- 738BR combination. Figure 5-2 shows the test setup for using the K02-738BR VTVM Calibration System.

NOTE

The 0.1 mV range of the 400F/FL may be checked for accuracy by verification of the additional 10 dB of gain that is provided by the meter amplifier on that range. In order to verify the gain, the top cover of the instrument must be removed to gain access to TP1 through TP4.

5-11. TOP COVER REMOVAL.

5-12. To remove or replace the top cover, follow the procedures outlined in Paragraph 5-23.

5-13. ACCURACY AND FREQUENCY RESPONSE CHECKS.

5-14. The accuracy and frequency response checks compare the Model 400F/FL with its accuracy specifications over the entire frequency range.

a. Connect the voltmeter calibrator, test oscillator, and 50 ohm termination to the Model 400F/FL as shown in Figure 5-1. An external switch, S1, may be used to facilitate switching from one test instrument to the other.

b. Set Model 400F/FL RANGE switch to 30 mV and set 100 kHz FILTER switch to OUT. Set switch S1 to A.

c. Set voltmeter calibrator for a 30 mV rms output at 400 Hz.

d. Observe the Model 400F/FL meter indication. If the meter indication is not within the tolerances listed in Table 5-2 for the 30 mV range at 400 Hz, perform the Meter Calibration (Paragraph 5-30). If indication is within tolerance, record actual meter reading.

e. Set Model 400F/FL RANGE switch to 100 mV. The meter should indicate 30 mV on 100 mV range.

f. Remove top cover and short TP1 to TP4, and short TP2 to TP3. (A shorting device, such as a crystal socket with its terminals shorted together, should be used to avoid pickup of noise.) If the meter indication is not the same as the indication in step d of this paragraph, perform the Meter Calibration (Paragraph 5-30). If the indication is within tolerance, record actual meter reading. This step verifies the accuracy of the additional 10 dB of gain provided by the meter amplifier on the 0.1 mV range.

g. Disconnect shorts between test points and set Model 400F/FL RANGE switch to 1 volt.

Table 5-2. Full Scale Calibration Tolerances

30 MV RANGE			100 MV RANGE (0.1 mv Range Check)			1 VOLT RANGE		
FREQ.	METER INDICATION		FREQ.	METER INDICATION		FREQ.	METER INDICATION	
	MIN.	MAX.		MIN.	MAX.		MIN.	MAX.
20	28.8	31.2	30	28.8	31.2	20	0.86	0.94
40	29.4	30.6	60	29.4	30.6	40	0.88	0.92
400	29.7	30.3	400	29.4	30.6	400	0.89	0.91
1000	29.7	30.3	1000	29.4	30.6	1000	0.89	0.91
10 K	29.7	30.3	10 K	29.4	30.6	10 K	0.89	0.91
100 K	29.7	30.3	100 K	29.4	30.6	100 K	0.89	0.91
1 M	29.7	30.3	500 K	27.6	30.3	1 M	0.89	0.91
2 M	29.4	30.6				2 M	0.88	0.92
4 M	28.8	31.2				4 M	0.86	0.94

h. Set voltmeter calibrator for a 0.9 volt rms output at 400 Hz. Observe the Model 400F/FL meter indication. If the meter indication is not within the tolerances listed in Table 5-2 for 1 volt range at 400 Hz, perform the Meter Calibration (Paragraph 5-30). If the indication is within tolerance, record the actual meter reading.

i. Set switch S1 to position B, set Model 400F/FL Range switch to 30 mV, and set test oscillator OUTPUT ATTENUATOR to 0.03 volt at 400 Hz.

j. Adjust test oscillator AMPLITUDE control for same meter indication on Model 400F/FL as recorded in step d of this paragraph.

k. Set test oscillator MONITOR to EXPAND and adjust REF SET for a center scale meter reference. (Do not readjust REF SET once a reference is obtained.)

l. Check Model 400F/FL meter tolerances for all frequencies listed in Table 5-2 (30 mV range). Adjust test oscillator AMPLITUDE control to maintain meter reference for each frequency.

m. Set test oscillator MONITOR to NORMAL and OUTPUT ATTENUATOR to 0.03 volt range. Set Model 400F/FL to 100 mV RANGE and short TP1 to TP4 and short TP2 to TP3.

n. Adjust test oscillator AMPLITUDE control for same meter indication on Model 400F/FL as recorded in step f of this paragraph.

o. Repeat steps k and l for the 100 mV range of Table 5-2.

p. Remove shorting devices, set Model 400F/FL to 1 volt RANGE, and set test oscillator MONITOR to NORMAL.

q. Set test oscillator OUTPUT ATTENUATOR to 1 volt range at 400 Hz and adjust test oscillator AMPLITUDE control for same meter indication on Model 400F/FL as recorded in step h of this paragraph.

r. Repeat steps k and l for 1 volt range of Table 5-2.

5-15. RANGE TRACKING CHECK.

5-16. After verifying the 400F/FL full scale calibration with the accuracy and frequency response tests, check the range tracking of the instrument with the following procedures. Use the test setup shown in Figure 5-1 for the range tracking check.

a. Set switch S1 to Position B.

b. Set 400F/FL RANGE switch to 30 mV.

c. Adjust test oscillator for a 400F/FL meter indication of 30 mV at 400 Hz.

d. Set 400F/FL RANGE switch to 100 mV.

1) 400F should indicate 30 mV ±2%.

2) 400FL should indicate 30 mV ±1%.

e. Set 400F/FL RANGE switch to 0.3 volts.

1) 400F should indicate 30 mV ±5%.

2) 400FL cannot be checked with a 1/10 scale input.

f. Adjust test oscillator for a 400F/FL meter indication of 30 mV at 1 MHz.

g. Set 400F/FL RANGE switch to 100 mV.

1) 400F should indicate 30 mV ±2%.

2) 400FL should indicate 30 mV ±1%.

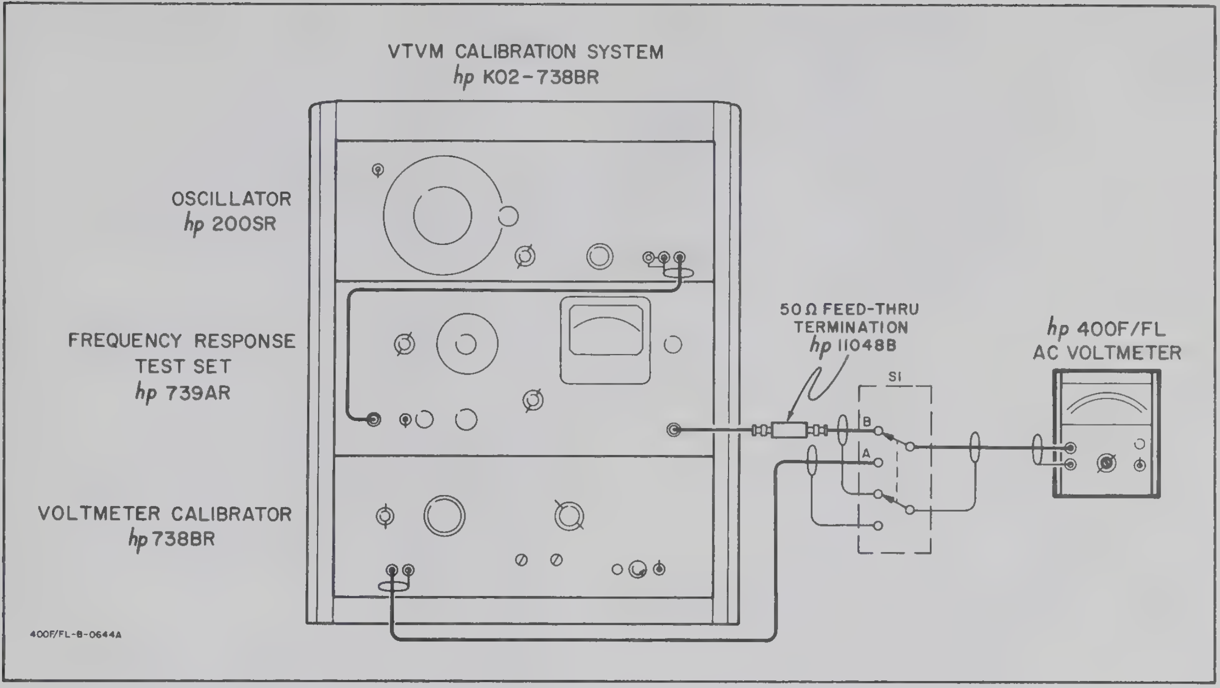


Figure 5-2. Alternate Accuracy and Frequency Response Check Setup

h. Set 400F/FL RANGE switch to 0.3 volts.

1) 400F should indicate 30 mV ±5%.

2) 400F/FL cannot be checked with a 1/10 scale input.

5-17. NOISE AND FILTER CHECK.

a. Connect a 1kΩ resistor across the input of Model 400F/FL.

b. Observe the noise level on Model 400F/FL with settings given in Table 5-3.

c. Noise should not exceed the levels given in Table 5-3.

Table 5-3. Noise Level Specifications

RANGE	Filter In	Filter Out
300 μV to 300 V	< 5 μV	< 30 μV
100 μV	< 5 μV	< 15 μV

5-18. INPUT IMPEDANCE CHECK.

5-19. INPUT RESISTANCE CHECK.

a. Connect the 50Ω output of the test oscillator to 400F/FL.

b. Set 400F/FL RANGE switch to 1 volt.

c. Set test oscillator output for full scale deflection of 400F/FL.

d. Connect a 100 kΩ resistor between test oscillator and 400F/FL as shown in Figure 5-3.

e. 400F/FL meter indication should not drop more than one small scale division from full scale. This verifies an input resistance of 10 MΩ.

5-20. INPUT CAPACITY CHECK.

a. Connect test oscillator and a 100 kΩ resistor to 400F/FL as shown in Figure 5-3. Connect the resistor lead directly to the GR connector.

b. Set 400F/FL RANGE switch to 1 volt.

c. Set test oscillator output for full scale deflection of 400F/FL meter at 400 Hz.

d. Increase frequency of test oscillator until 400F/FL indication drops to 0.707 volts. This should occur at a frequency of 106 kHz or greater, verifying an input capacity of 15 pF or less on the 1 volt range.

e. Set 400F/FL RANGE switch to 300 mV.

f. Set frequency response test set output for an indication of 300 mV on the 400F/FL meter at 400 Hz.

g. Increase frequency of test oscillator until 400F/FL indication drops to 212 mV. This should occur at a frequency of 53 kHz or greater, verifying an input capacity of 30 pF or less on the 300 mV range.

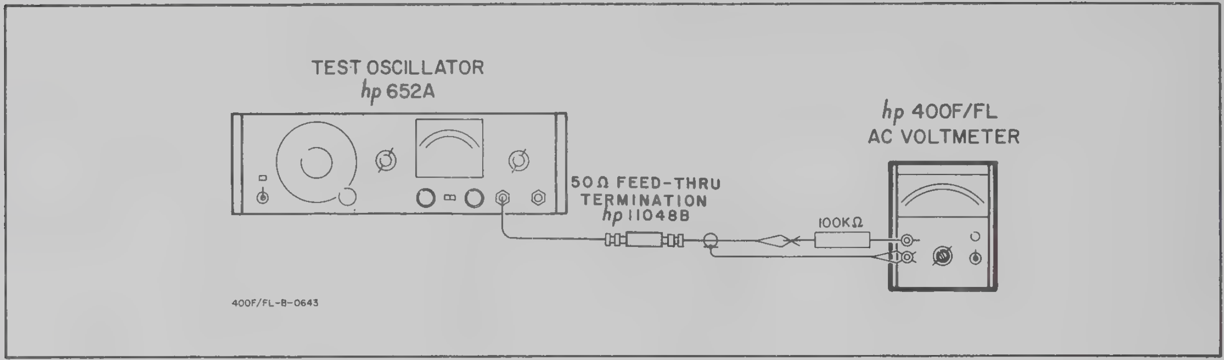


Figure 5-3. Input Impedance Check Setup

5-21. ALIGNMENT AND CALIBRATION PROCEDURES.

5-22. The Alignment and Calibration Procedures should be performed only if it has been determined by the Performance Checks that the 400F/FL is not within specifications. The following procedures specify the use of an -hp- 738BR Voltmeter Calibrator and an -hp- 652A Test Oscillator. However, an -hp- K02-738BR VTVM Calibration System may be substituted by following the same general procedures. If the instrument cannot be properly adjusted, refer to Paragraph 5-41, Troubleshooting Procedures. Refer to Figure 5-4 for the location of internal adjustments.

5-23. COVER REMOVAL AND REPLACEMENT.

5-24. Removal of the top cover exposes circuit areas for routine checks and adjustments. Removal of the bottom and side covers exposes circuit areas for operations such as soldering and component replacement.

5-25. TOP OR BOTTOM COVERS.

a. Remove screws securing cover. Slide cover about 1 inch to rear, and lift it off.

b. To replace cover, reverse the removal procedure.

5-26. SIDE COVER.

5-27. Remove the four screws from side cover, and lift it off.

5-28. METER MECHANICAL ZERO ADJUSTMENT.

5-29. Refer to Paragraph 3-5 for the meter mechanical zero adjustment procedures.

5-30. METER CALIBRATION.

5-31. The following procedures are used to adjust the gain of the meter amplifier on two voltage ranges at five different frequencies. Proper gain adjustments will assure accurate meter indications over the entire

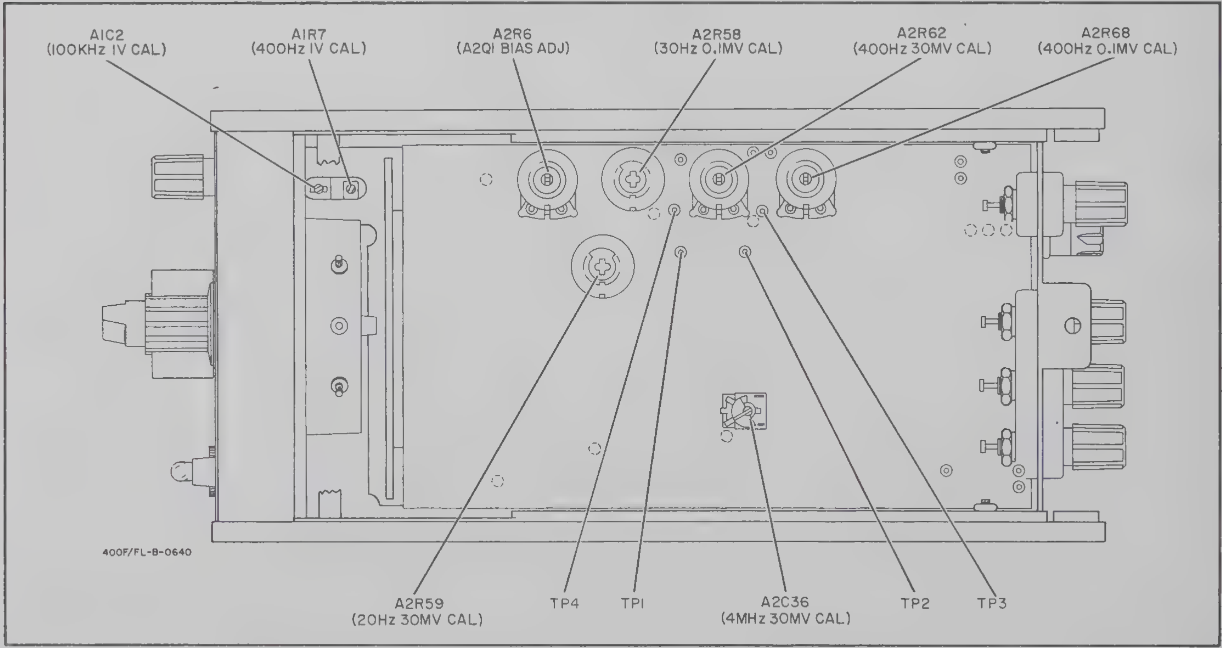


Figure 5-4. Location of Internal Adjustments

voltage and frequency range of the instrument. Use the test setup shown in Figure 5-1 for the meter calibration.

5-32. METER CALIBRATION, 30 MV RANGE.

a. Set switch S1 to Position A.

b. Set 400F/FL RANGE switch to 30 mV, and set 100 kHz L. P. FILTER switch to OUT.

c. Set voltmeter calibrator for 30 mV output at 400 Hz.

d. Adjust A2R62 for a 400F/FL meter indication of 30 mV.

e. Set switch S1 to Position B.

f. Adjust test oscillator for a 400F/FL meter indication of 30 mV at 400 Hz. Set a reference on meter of test oscillator and use amplitude control to maintain reference whenever frequency of oscillator is changed.

g. Set test oscillator to 20 Hz, maintaining amplitude at 30 mV.

h. Adjust A2R59 for a 400F/FL meter indication of 30 mV.

i. Set test oscillator to 4 MHz, maintaining amplitude at 30 mV.

j. Adjust A2C36 for a 400F/FL meter indication of 30 mV.

5-33. METER CALIBRATION, 0.1 MV RANGE.

NOTE

The 0.1 mV range meter calibration is performed on a higher range. This is done by shorting test points which provide the amplifier with the additional 10 dB of gain that normally is switched in only on the 0.1 mV range.

a. Set switch S1 to Position B.

b. Set 400F/FL RANGE switch to 30 mV, and set 100 kHz L. P. FILTER switch to OUT.

c. Adjust test oscillator for a 400F/FL meter indication of 30 mV at 400 Hz.

d. Set 400F/FL RANGE switch to 100 mV.

e. Short TP1 to TP4 and short TP2 to TP3. (This increases the gain of the meter amplifier by 10 dB, as if the instrument were on the 0.1 mV range.)

f. Adjust A2R68 for a 400F/FL meter indication of 30 mV. (Although the 400F/FL RANGE switch is in the 100 mV position, the instrument effectively is still on the 30 mV range.)

g. Set test oscillator to 30 Hz, maintaining amplitude at 30 mV.

h. Adjust A2R58 for a 400F/FL meter indication of 30 mV.

5-34. ATTENUATOR ALIGNMENT.

5-35. The following procedures are used to properly align the input attenuator of the 400F/FL at both high and low frequencies. Use the test setup shown in Figure 5-1 for the attenuator alignment.

a. Set switch S1 to Position A.

b. Set 400F/FL RANGE switch to 1 volt, and set 100 kHz L. P. FILTER switch to OUT.

c. Adjust voltmeter calibrator for a 1 volt output at 400 Hz.

d. Adjust A1R7 for a 400F/FL meter indication of 1 volt.

e. Set switch S1 to Position B.

f. Set test oscillator for a 400F/FL meter indication of 1 volt at 400 Hz.

g. Set test oscillator to 100 kHz, maintaining the amplitude at 1 volt.

h. Adjust A1C2 for a 400F/FL meter indication of 1 volt. If more than a 1% adjustment is needed, repeat the 400 Hz adjustment.

5-36. A2Q1 BIAS ADJUSTMENT.

5-37. A2R6 provides a bias adjustment for field effect transistor A2Q1.

a. Monitor voltage at junction between A2R5 and A2R3 with a dc voltmeter.

b. Adjust A2R6 for a +6V indication at the junction. See APPENDIX C, CHANGE #2.

5-38. REPLACEMENT OF A2C37*.

5-39. The value of A2C37 is individually selected to compensate for varying circuit parameters within the instrument. Certain Model 400F/FL instruments may not have a capacitor in this location.

5-40. If an instrument cannot be properly calibrated on the 30 mV range at 4 MHz, A2C37 should be changed. Increase the value of A2C37 if the instrument meter indication is high and cannot be adjusted low enough. Decrease the value of A2C37 if the instrument meter indication is low and cannot be adjusted high enough.

5-41. TROUBLESHOOTING PROCEDURE.

5-42. The following paragraphs are included as an aid to troubleshooting the Model 400F/FL. No attempt is made in these checks to measure every circuit parameter, but to provide guidelines for localizing a malfunction. Read Section IV for an understanding of circuit operation before attempting to do any troubleshooting.

5-43. When the Model 400F/FL is suspected of faulty operation perform the Alignment and Calibration Procedures in Paragraph 5-21. The malfunction may be no more than an adjustment out of tolerance. Usually the Alignment and Calibration Procedure will assist in localizing the trouble, whether it is an adjustment or a defective component.

Table 5-4. Front Panel Troubleshooting Guide

SYMPTOM	POSSIBLE CAUSE
Inoperative on 0.1 mV RANGE through 0.3V RANGE.	Relay A2K1 stuck open or A2K2 stuck closed.
Inoperative on 1V RANGE through 300V RANGE.	Relay A2K1 stuck closed or A2K2 stuck open.
Meter deflection on all ranges with no input.	Check A2Q15, A2Q16, A2Q17, A2C38, A2C39, and A2C40.
Meter remains at zero, on all ranges, with any input.	Check CR1 (400F only) or C1 (400FL only) for a short. Check A2CR22 and A2CR23.
Meter is erratic and/or inaccurate on all ranges.	Check +26 volt and -26 volt supplies. Check A2Q11, A2Q16 and A2Q17.
Meter is erratic and/or inaccurate on high sensitivity ranges.	Check RANGE switch contacts (S1) and A2Q1.
Meter reads low with 4 MHz input.	Check S1CR1, S1CR2, A2CR3, and A2CR16.
Meter reads low with 2 MHz input.	Check A2C10 and A2R44.
Excessive noise.	Check A2Q1 and A2R60.

5-44. Visually inspect the Model 400F/FL for any indication of a mechanical or electrical failure. Check for broken or loose connectors or wires, and charred or discolored components. Look for anything unusual that may indicate a malfunction.

5-45. Refer to Table 5-4 for a list of trouble symptoms and the possible cause.

5-46. POWER SUPPLY.

5-47. The Model 400F/FL has a +26V power supply and a -26V power supply. It is important to remember that the -26V supply is referenced to the +26V supply. Troubleshoot the -26V supply only after it has been ascertained that the +26V supply is operating properly.

5-48. Both supplies have a jumper wire that can be lifted to disconnect the load. If a supply should read low, lift the jumper wire and measure the voltage. If the voltage returns to normal, the trouble is external to the power supply. Check the external circuit to determine where the excess current is being drawn from the supply. If the voltage does not return to normal, or if the voltage is high, the trouble is in the power supply. Troubleshoot the power supply using the dc voltages provided on the schematic diagram, Figure 6-3.

5-49. PREAMPLIFIER.

5-50. When operating normally the Preamplifier has a gain of 10 dB. With a 1 volt, 400 Hz, rms input on the 1V RANGE of the Model 400F/FL, a 1 mV signal will be present at A2R17. Measure the signal at A2R17. If it is 1 mV, measure the signal at A2C4. For 10 dB of gain the signal amplitude at A2C4 should be 3.16 mV. Troubleshoot the Preamplifier using the DC voltages shown on the schematic diagram, Figure 6-3, if the signal at A2C4 does not measure 3.16 mV.

5-51. Measure the +6V bias at A2R8. If the +6V bias is low and cannot be adjusted with A2R6, BIAS ADJ, check for an open A2L1, A2L2 or A2Q1. Also check A2Q2 and A2Q3 for a short. If the +6V bias is high, check for an open A2Q2 or A2Q3. Use the DC voltages shown on the schematic diagram, Figure 6-3, to aid in isolating a faulty component.

5-52. METER AMPLIFIER.

5-53. When the meter needle fails to deflect with a signal input, the problem may be a faulty transistor in the Meter Amplifier. Measure the DC voltages shown on the schematic diagram, Figure 6-3, to isolate a faulty component in the Meter Amplifier. Often a problem in the Meter Amplifier will also cause erroneous DC voltage readings in the Meter Bridge.

5-54. If A2Q14 and associated circuitry are not operating properly, it may alter the performance of the Meter Amplifier to make it appear that the Meter Amplifier is at fault. Check A2Q14 and associated circuitry when the Meter Amplifier is suspected of faulty operation.

5-55. METER BRIDGE.

5-56. Measure the voltage at the collector of A2Q16. The voltage should read -9V. If the voltage is -18V, check A2CR23. When the voltage at the collector of A2Q16 is -18V the meter needle will remain pegged below zero with any input. If the voltage at the collector of A2Q16 is OV, check A2CR22. When the voltage reading is OV the Model 400F/FL meter needle will remain at zero with any input.

5-57. ETCHED CIRCUIT BOARD REPAIR.

5-58. The Model 400F/FL uses plated through, double-sided, etched circuit boards. To prevent damage to the circuit board and components, observe the following rules when soldering:

a. Use a low-heat (25 to 50 watts) soldering iron with a small tip (1/16" to 3/32" diameter).

CAUTION

EXCESSIVE OR PROLONGED HEAT CAN LIFT THE CIRCUIT FOIL FROM THE BOARD OR CAUSE DAMAGE TO COMPONENTS.

b. To remove a component, clip a heat sink (long nose pliers, commercial heat sink tweezers etc.) on the component lead as close to the component as possible. Place the soldering iron directly on the component lead, and pull up on the lead. If a component is obviously damaged or faulty, clip the leads close to the component and then remove the leads from the board.

c. Clean the component lead holes by heating the solder in the hole, quickly removing the soldering iron, and inserting a pointed, non-metallic object such as a toothpick.

d. To mount a new component, shape the leads and insert them in the holes. Clip a heat sink on the component, heat with the soldering iron, and add solder as necessary to obtain a good electrical connection.

e. Clip excess leads off after soldering and clean excess flux from the connection and adjoining area, using type TF Freon (-hp- Part No. 8500-0232).

PERFORMANCE CHECK TEST CARD

Hewlett-Packard Model 400F/FL
AC Voltmeter
Serial No. ____________

Test performed by ____________
Date ____________

DESCRIPTION	CHECK			
ACCURACY AND FREQUENCY RESPONSE:	METER INDICATION			
30 MV RANGE	Min.			Max.
20 Hz	28.8		____	31.2
40 Hz	29.4		____	30.6
400 Hz	29.7		____	30.3
1000 Hz	29.7		____	30.3
10 kHz	29.7		____	30.3
100 kHz	29.7		____	30.3
1 MHz	29.7		____	30.3
2 MHz	29.4		____	30.6
4 MHz	28.8		____	31.2
100 MV RANGE (0.1 mV Range Check)	METER INDICATION			
	Min.			Max.
30 Hz	28.8		____	31.2
60 Hz	29.4		____	30.6
400 Hz	29.4		____	30.6
1000 Hz	29.4		____	30.6
10 kHz	29.4		____	30.6
100 kHz	29.4		____	30.6
500 kHz	27.6		____	30.3
1 V RANGE	METER INDICATION			
	Min.			Max.
20 Hz	0.86		____	0.94
40 Hz	0.88		____	0.92
400 Hz	0.89		____	0.91
1000 Hz	0.89		____	0.91
10 kHz	0.89		____	0.91
100 kHz	0.89		____	0.91
1 MHz	0.89		____	0.91
2 MHz	0.88		____	0.92
4 MHz	0.86		____	0.94
RANGE TRACKING:	METER INDICATION			
400 Hz	Min.			Max.
100 mV	400F	29.4	____	30.6
	400FL	29.7	____	30.3
0.3V	400F	28.5	____	31.5
	400FL		No indication at 1/10 scale	
1 MHz				
100 mV	400F	29.4	____	30.6
	400FL	29.7	____	30.3
0.3V	400F	28.5	____	31.5
	400FL		No indication at 1/10 scale	

PERFORMANCE CHECK TEST CARD (Cont'd)

DESCRIPTION	CHECK
NOISE AND FILTER CHECK:	METER INDICATION
0.3 mV FILTER IN	5 μV or less ________
0.3 mV FILTER OUT	30 μV or less ________
0.1 mV FILTER IN	5 μV or less ________
0.1 mV FILTER OUT	15 μV or less ________
INPUT IMPEDANCE:	METER INDICATION
Resistance	10 MΩ or greater ________
Capacity	15 pF or less on 10 V range ________
	30 pF or less on 300 mV range ________

SECTION VI
SCHEMATICS

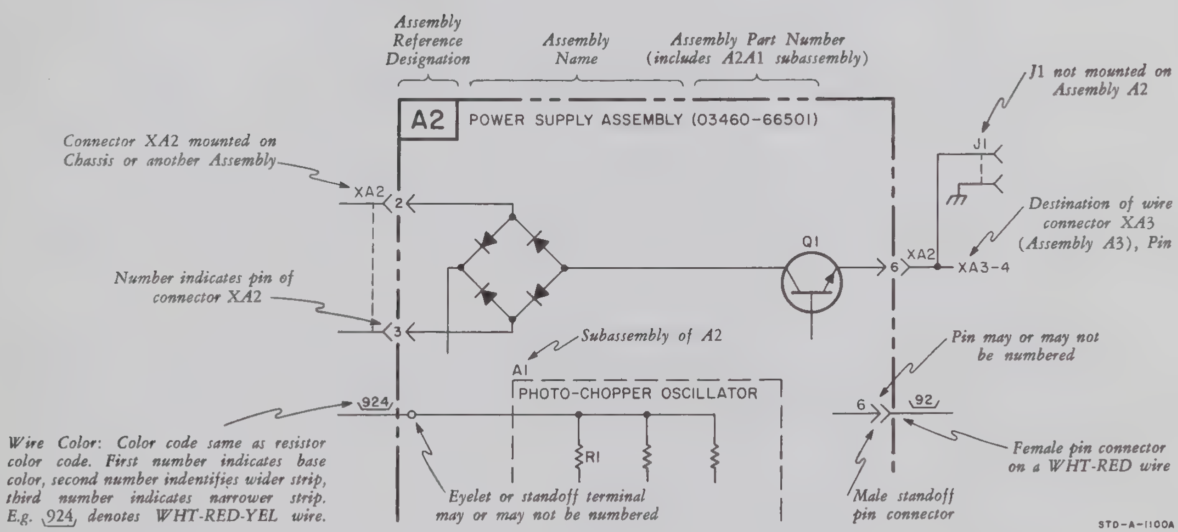
6-1. INTRODUCTION.

6-2. This section contains the schematic and component location diagrams for the Model 400F/FL. Figure 6-1 shows a flattened view of the RANGE switch and part of the internal wiring data. Figure 6-2 shows the component location on the A1 and A2 printed circuit boards, and the location of the internal adjustments. Figure 6-3 is the schematic diagram of the 400F/FL. Main signal paths and feedback paths are identified. (Refer to the notes on the schematic diagram.)

REFERENCE DESIGNATIONS

PARTIAL REFERENCE DESIGNATIONS ARE SHOWN: PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.

ASSEMBLY	SUBASSEMBLY	COMPONENT	COMPLETE DESIGNATION
A2	NONE	Q1	A2Q1
A2	A1	R1	A2A1R1
NONE	NONE	J1	J1



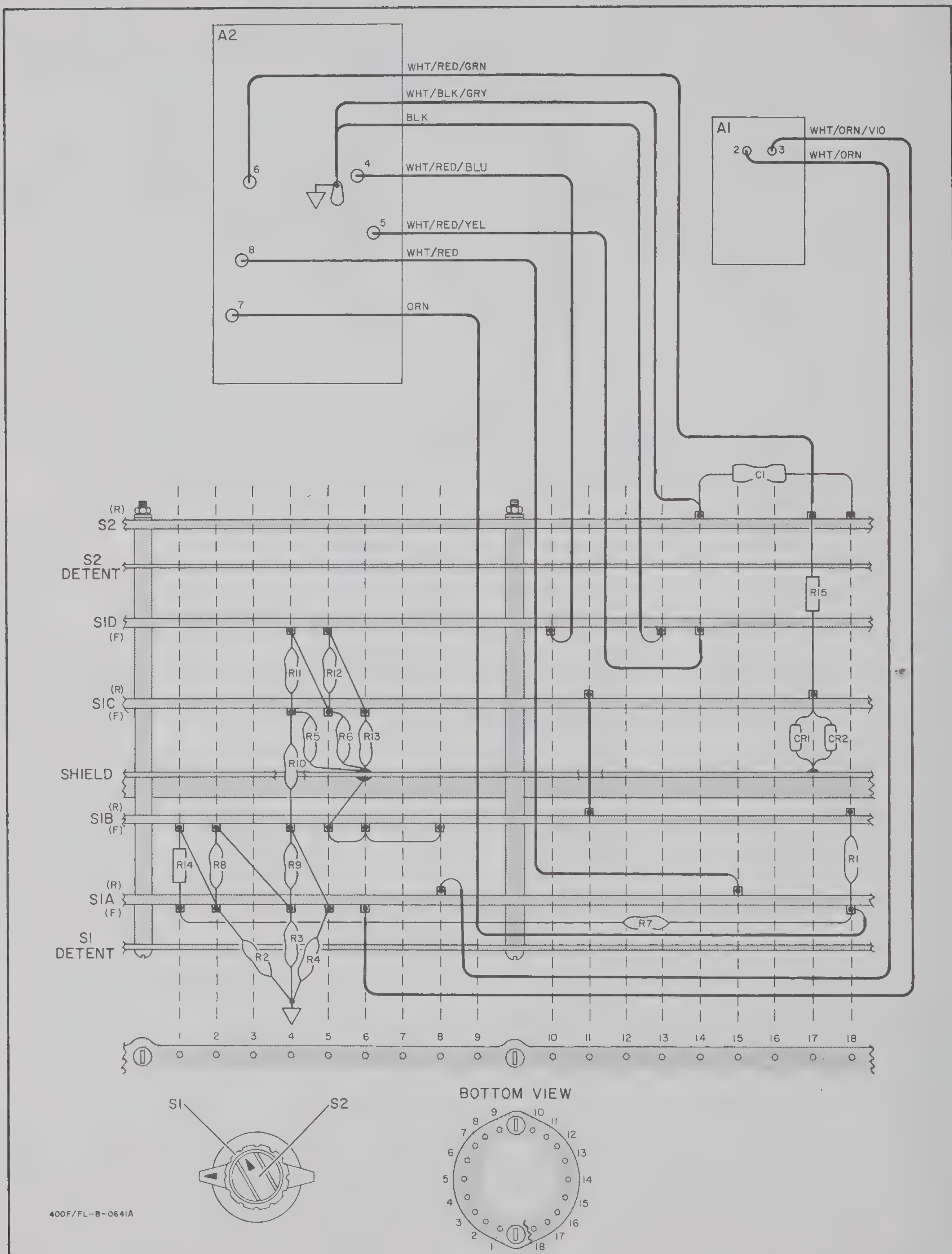
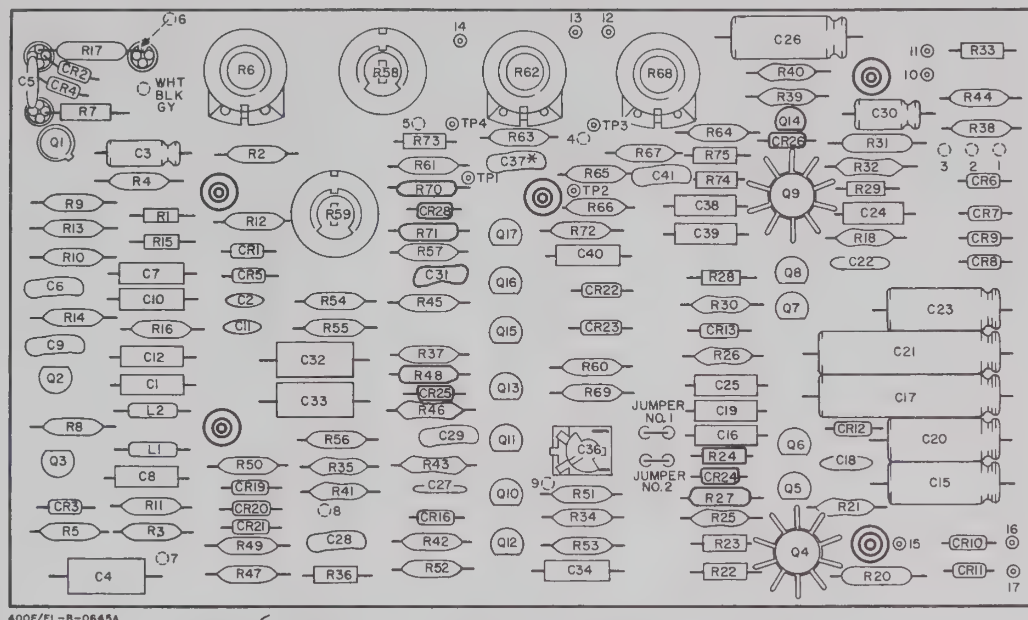


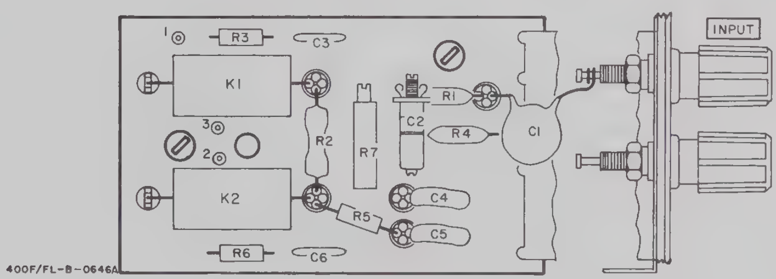
Figure 6-1. Model 400F/FL Range Switch and p/o Internal Wiring Data



PIN AND WIRE COLOR

1-RED	5-WHT/RED/YEL	9-WHT/RED/GRN	13-BLK	17-VIO
2-YEL	6-WHT/YEL/ORN	10-BLK	14-BLK	
3-RED/YEL	7-ORN	11-GRN	15-BLK	
4-WHT/RED/BLU	8-WHT/RED	12-WHT	16-RED	

A2 BOARD (-hp- Part No. 00400-66504)



A1 BOARD (-hp- Part No. 00400-66505)

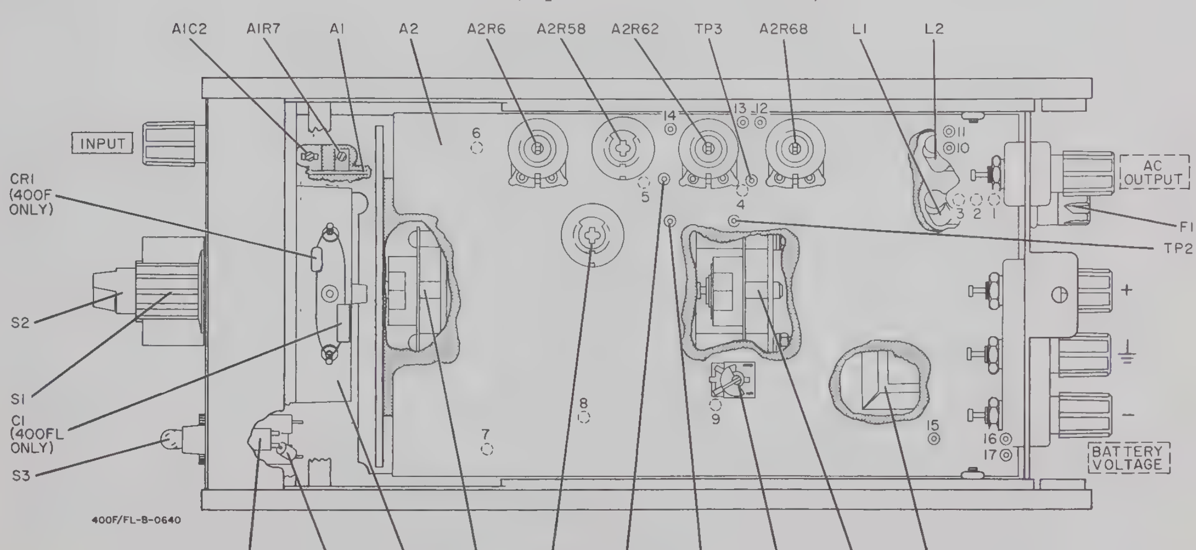


Figure 6-2. Model 400F/FL Component Location

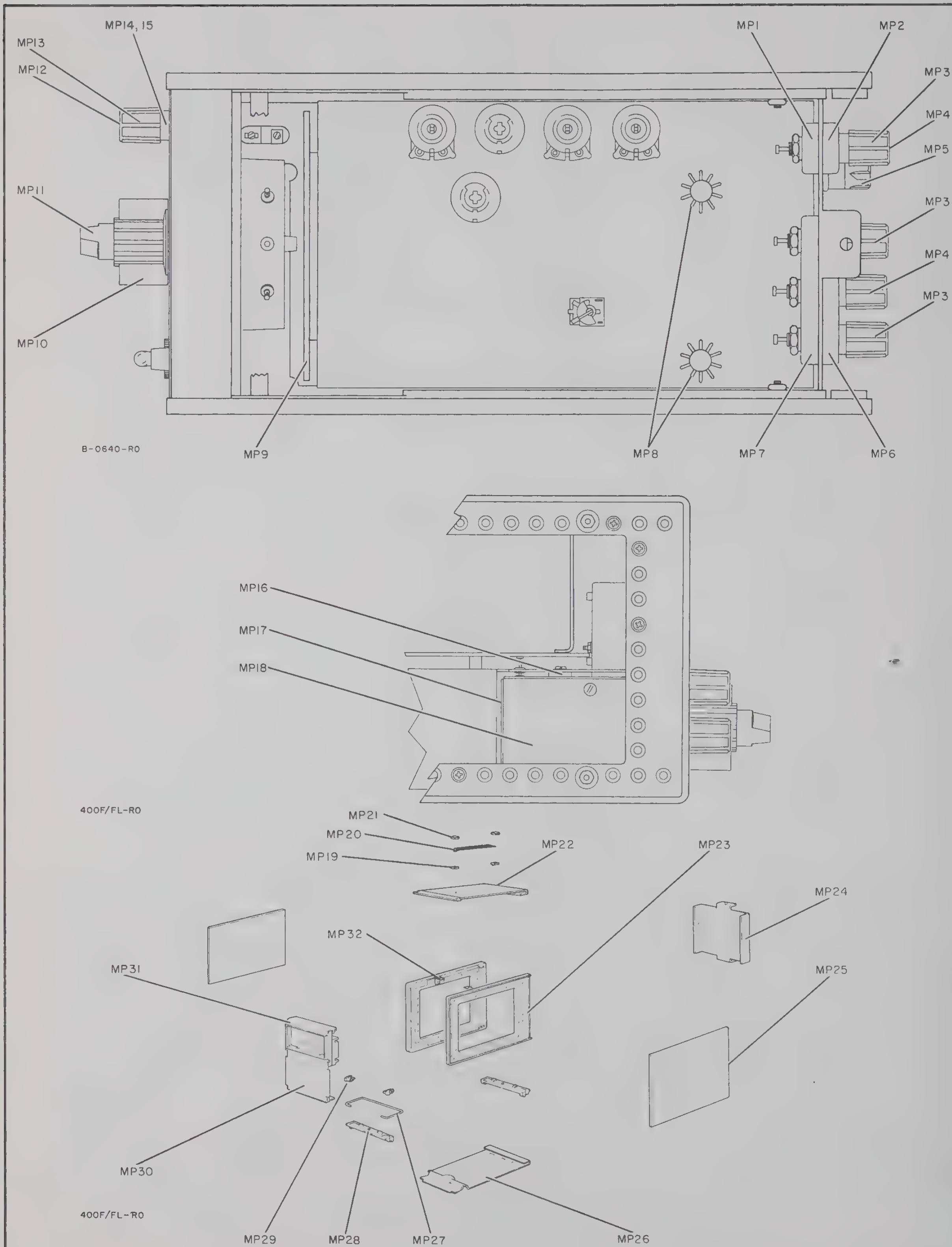


Figure 7-1. Location of Important Mechanical Parts

SECTION VII
REPLACEABLE PARTS

7-1. INTRODUCTION.

7-2. This section contains information for ordering replacement parts. Table 7-1 lists parts in alphameric order of their reference designators and indicates the description, -hp- part number of each part, together with any applicable notes, and provides the following:

a. Description of the part. (See list of abbreviations below.)

b. Typical manufacturer of the part in a five-digit code. (See Appendix A for list of manufacturers.)

c. Manufacturer's part number.

d. Total quantity used in the instrument (TQ column). Total quantity of a part is given the first time the part number appears.

7-3. Miscellaneous parts are listed at the end of Table 7-1.

7-4. ORDERING INFORMATION.

7-5. To obtain replacement parts, address order or inquiry to your local Hewlett-Packard Field Office. (See Appendix B for list of office locations.) Identify parts by their Hewlett-Packard part numbers.

7-6. NONLISTED PARTS.

7-7. To obtain a part that is not listed, include:

a. Instrument model number.

b. Instrument serial number.

c. Description of the part.

d. Function and location of the part.

DESIGNATORS

A	= assembly
B	= motor
BT	= battery
C	= capacitor
CR	= diode
DL	= delay line
DS	= lamp
E	= misc electronic part
F	= fuse
FL	= filter
HR	= heater
IC	= integrated circuit
J	= jack
K	= relay
L	= inductor
M	= meter
MP	= mechanical part
P	= plug
Q	= transistor
QCR	= transistor-diode
R	= resistor
RT	= thermistor
S	= switch
T	= transformer
TC	= thermocouple
V	= vacuum tube, neon bulb, photocell, etc.
W	= cable
X	= socket
XDS	= lampholder
XF	= fuseholder
Z	= network

ABBREVIATIONS

Ag	= silver
Al	= aluminum
A	= ampere (s)
Au	= gold
C	= capacitor
cer	= ceramic
coef	= coefficient
com	= common
comp	= composition
conn	= connection
dep	= deposited
DPDT	= double-pole double-throw
DPST	= double-pole single-throw
elect	= electrolytic
encap	= encapsulated
F	= farad (s)
FET	= field effect transistor
fxd	= fixed
GaAs	= gallium arsenide
GHz	= gigahertz = 10^{+9} hertz
gd	= guard (ed)
Ge	= germanium
grd	= ground (ed)
H	= henry (ies)
Hg	= mercury
Hz	= hertz (cycle (s) per second)
ID	= inside diameter
impg	= impregnated
incd	= incandescent
ins	= insulation (ed)
kΩ	= kilohm (s) = 10^{+3} ohms
kHz	= kilohertz = 10^{+3} hertz
L	= inductor
lin	= linear taper
log	= logarithmic taper
m	= milli = 10^{-3}
mA	= milliampere (s) = 10^{-3} amperes
MHz	= megahertz = 10^{+6} hertz
MΩ	= megohm (s) = 10^{+6} ohms
met flm	= metal film
mfr	= manufacturer
mtg	= mounting
mV	= millivolt (s) = 10^{-3} volts
μ	= micro = 10^{-6}
μV	= microvolt (s) = 10^{-6} volts
my	= Mylar ®
nA	= nanoampere (s) = 10^{-9} amperes
NC	= normally closed
Ne	= neon
NO	= normally open
NPO	= negative positive zero (zero temperature coefficient)
ns	= nanosecond (s) = 10^{-9} seconds
nsr	= not separately replaceable
Ω	= ohm (s)
obd	= order by description
OD	= outside diameter
p	= peak
pc	= printed circuit
pF	= picofarad (s) = 10^{-12} farads
piv	= peak inverse voltage
p/o	= part of
pos	= position (s)
poly	= polystyrene
pot	= potentiometer
p-p	= peak-to-peak
ppm	= parts per million
prec	= precision (temperature coefficient, long term stability, and/or tolerance)
R	= resistor
Rh	= rhodium
rms	= root-mean-square
rot	= rotary
Se	= selenium
sect	= section (s)
Si	= silicon
sl	= slide
SPDT	= single-pole double-throw
SPST	= single-pole single-throw
Ta	= tantalum
TC	= temperature coefficient
TiO_2	= titanium dioxide
tog	= toggle
tol	= tolerance
trim	= trimmer
TSTR	= transistor
V	= volt (s)
vacw	= alternating current working voltage
var	= variable
vdcw	= direct current working voltage
W	= watt (s)
w/	= with
wiv	= working inverse voltage
w/o	= without
ww	= wirewound
*	= optimum value selected at factory, average value shown (part may be omitted)
**	= no standard type number assigned (selected or special type)

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Table 7-1. Replaceable Parts

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A1	00400-66505		1	Assembly: board etched circuit includes C1 through C6 K1 through K2 R1 through R7	-hp-	
A1C1	0150-0012		1	C: fxd cer 0.01 μF ±20% 1000 vdcw	56289	29C214A3
A1C2	0121-0407		1	C: var trimmer 0.7 to 3.0 pF	72982	536-016
A1C3	0150-0093		2	C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
A1C4	0140-0179		1	C: fxd mica 1000 pF ±2%	04062	RDM
A1C5	0140-0156		1	C: fxd mica 1500 pF ±2%	04062	RDM19F152G3C
A1C6	0150-0093			C: fxd 0.01 μF +80% -20% 100 vdcw	91418	TA obd
A1K1	0490-0478		1	Relay: reed high voltage	-hp-	
A1K2	0490-0343		1	Relay: reed low voltage	-hp-	
A1R1	0757-0346		2	R: fxd prec met flm 10 ohms ±1% 1/8 W	91637	MFF 1/8 T-O obd
A1R2	0698-4128		1	R: fxd prec met flm 10M ± 0.25%	03888	PME 70-T-2
A1R3	0684-2211		2	R: fxd comp 220 ohms ±10% 1/4 W	01121	CB-2211
A1R4	0698-4475		1	R: fxd prec met flm 9.76 kΩ ±1% 1/8 W	91337	MFF 1/8 T-O obd
A1R5	0683-0625		1	R: fxd comp 6.2 ohms ±5% 1/4 W	01121	CB-62G5
A1R6	0684-2211			R: fxd comp 220Ω ±10% 1/4 W	01121	CB-2211
A1R7	2100-1799		1	R: var ww 500Ω ±10% 1 W	02660	2600 Series
A2	00400-66504		1	Assembly: board etched circuit includes C1 through C12 CR19 through CR28 C15 through C34 L1, L2 C36 through C41 Q1 through Q17 CR1 through CR13 R1 through R18 CR16 R20 through R75	-hp-	
A2C1	0180-0100		10	C: fxd Ta 4.7 μF ±10% 35 vdcw	56289	1500475X9035B2
A2C2	0150-0122		3	C: fxd 0.002 μF ±20% 500 vdcw	72982	801-000-Y55-202M
A2C3	0180-0119		1	C: fxd Al elect 1 μF +75% -10% 25 vdcw	56289	30D105G025BA2-DSM
A2C4	0180-0137		2	C: fxd Ta elect 100 μF ±20% 10 vdcw	56289	150D107X0010R2
A2C5	0150-0084		1	C: fxd cer 0.1 μF +80% -20% 50 vdcw	56289	33C41 obd
A2C6	0160-2024		1	C: fxd 75 pF ±5% 500 vdcw	00853	obd
A2C7	0180-0106			C: fxd Ta elect 60 μF ±20% 6 vdcw	56289	150D606X0006B2
A2C8	0180-0100			C: fxd Ta 4.7 μF ±10% 35 vdcw	56289	1500475X9035B2
A2C9	0140-0198		1	C: fxd mica 200 pF ±5% 300 vdcw	04062	RDM15F201J3C
A2C10	0180-0100			C: fxd Ta 4.7 μF ±10% 35 vdcw	56289	1500475X9035B2
A2C11	0150-0122			C: fxd 0.002 μF ±20% 500 vdcw	72982	801-000-Y55-202M
A2C12	0180-0100			C: fxd Ta 4.7 μF ±10% 35 vdcw	56289	1500475X9035B2
A2C13, A2C14				Not assigned		
A2C15	0180-0061		3	C: fxd Al elect 100 μF +75% -10% 15 vdcw	56289	30D107G015DC2-DSM
A2C16	0180-0100			C: fxd Ta 4.7 μF ±10% 35 vdcw	56289	1500475X9035B2
A2C17	0180-1819		2	C: fxd Al elect 100 μF +75% -10% 50 vdcw	56289	30D107G050DH2-DSM
A2C18	0150-0024		2	C: fxd cer 0.02 μF +80% -20% 600 vdcw	72982	841-000-25U-203Z
A2C19	0180-0100			C: fxd Ta 4.7 μF ±10% 35 vdcw	56289	1500475X9035B2
A2C20	0180-0061			C: fxd Al elect 100 μF +75% -10% 15 vdcw	56289	30D107G015DC2-DSM
A2C21	0180-1819			C: fxd Al elect 100 μF +75% -10% 50 vdcw	56289	30D107G050DH2-DSM
A2C22	0150-0024			C: fxd cer 0.02 μF +80% -20% 600 vdcw	72982	841-000-25U-203Z
A2C23	0180-0061			C: fxd Al elect 100 μF +75% -10% 15 vdcw	56289	30D107G015DC2-DSM
A2C24, A2C25	0180-0100			C: fxd Ta 4.7 μF±10% 35 vdcw	56289	1500475X9035B2
A2C26	0180-0058		1	C: fxd Al elect 50 μF +75% -10% 25 vdcw	56289	30D506G025CC2-DSM

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2C27	0150-0122			C: fxd 0.002 μF ±20% 500 vdcw	72982	801-000-Y55-202M
A2C28	0140-0195		1	C: fxd mica 130 pF ±5% 300 vdcw	04062	RDM15F131J3C
A2C29	0140-0190		1	C: fxd mica 39 pF ±5%	04062	RDM15E390J3C
A2C30	0180-0224		1	C: fxd Al elect 10 μF 15 vdcw	56289	30D106G015BA4
A2C31	0140-0208		1	C: fxd mica 680 pF ±5% 300 vdcw	04062	RDM15F681J3C
A2C32, A2C33	0180-0137			C: fxd Ta elect 100 μF ±20% 10 vdcw	56289	150D107X0010R2
A2C34	0180-0100			C: fxd Ta 4.7 μF ±10% 35 vdcw	56289	1500475X9035B2
A2C35				Not assigned		
A2C36	0121-0127		1	C: var 1.7 to 11 pF single section	74970	189-5-5
A2C37*	0140-0201		1	C: fxd mica 12 pF ±5% 500 vdcw	72136	RDM15C120J5C
A2C38, A2C39	0180-0393		2	C: fxd Ta 39 pF ±10% 10 vdcw	56289	150D396X9010B2
A2C40	0180-0100			C: fxd Ta 4.7 μF ±10% 35 vdcw	56289	1500475X9035B2
A2C41	0140-0149		1	C: fxd mica 470 pF ±5% 300 vdcw	04062	DM15F471J
A2CR1	1902-0022		2	Diode: breakdown 2.67V ±10% 4 mW	07910	CD35540
A2CR2	1901-0044		2	Diode: Si 50 mA at +1V 10 na reverse current 50 wiv 2 pF	07910	obd
A2CR3	1901-0040		15	Diode: Si 30 mA at +10 V piv 12 pF 2 ns	07910	CD6319 obd
A2CR4	1901-0044			Diode: Si 50 mA at +1 V 10 na reverse current 50 wiv 2 pF	07910	obd
A2CR5	1902-0022			Diode: breakdown 2.67V ±10% 4 mW	07910	CD35540
A2CR6 through A2CR11	1901-0033		6	Diode: Si 100 mA at 1 V 180 piv 1N485B	93332	D6238 obd
A2CR12	1901-0040			Diode: Si 30 mA at +10V piv 12 pF 2 ns	07910	CD6319 obd
A2CR13	1902-3125		1	Diode: Si 6.98 V ±2% 400 mW	07263	obd
A2CR14, A2CR15				Not assigned		
A2CR16	1901-0040			Diode: Si 30 mA at +10V piv 12 pF 2 ns	07910	CD6319 obd
A2CR17, A2CR18				Not assigned		
A2CR19 through A2CR21	1901-0040			Diode: Si 30 mA at +10V piv 12 pF 2 ns	07910	CD6319 obd
A2CR22, A2CR23	1901-0027		2	Diode: Si 1N4392	73293	obd
A2CR24, 25, 26	1901-0040			Diode: Si 30 mA at 30 wiv 2 pF 2 ns	07910	CD6319 obd
A2CR27				Not assigned		
A2CR28	1901-0040			Diode: Si 30 mA at 30 wiv 2 pF 2 ns	07910	CD6319 obd
A2L1, A2L2	9140-0047		2	Inductor: fxd 20 μH ±10%	99848	H 51074020
A2Q1	1855-0046		1	TSTR: Si FET N channel	01295	SFB 1252
A2Q2	1853-0036		7	TSTR: Si PNP 2N3906	04713	2N3906-5
A2Q3	1854-0314		1	TSTR: Si NPN 310 mW 320 MHz	04713	MPS6521
A2Q4	1854-0039		2	TSTR: Si NPN 2N3052	86684	2N3053
A2Q5, A2Q6	1854-0215		6	TSTR: Si NPN 2N3904	04713	2N3904
A2Q7, A2Q8	1853-0036		6	TSTR: Si PNP 2N3906	04713	2N3906
A2Q9	1854-0039			TSTR: Si NPN 2N3053	86684	2N3053
A2Q10	1854-0215			TSTR: Si NPN 2N3904	04713	2N3904
A2Q11	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906
A2Q12 through A2Q14	1854-0215			TSTR: Si NPN 2N3904	04713	2N3904
A2Q15 through A2Q17	1853-0036			TSTR: Si PNP 2N3906	04713	2N3906
A2R1	0698-4121		5	R: fxd prec comp 11.3 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R2	0757-0474		4	R: fxd prec met flm 243 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R3	0686-3625		1	R: fxd comp 3.6 kΩ ±5% 1/2 W	01121	EB 3625
A2R4	0698-3178		2	R: fxd prec met flm 487Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R5	0698-4196		5	R: fxd prec met flm 1.07 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R6	2100-0095		1	R: var comp lin 100 kΩ ±30% 0.10 W	71450	UPE 70RE (hp)
A2R7	0686-2265		1	R: fxd comp 22M ±5% 1/2 W	01121	EB-2265

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2R8	0757-0410		1	R: fxd prec met flm 301Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R9	0757-0434		11	R: fxd prec met flm 3.65 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R10	0698-3510		2	R: fxd prec met flm 453Ω ±1% 1, 8 W	91637	MFF-1/8 T-O obd
A2R11	0698-4457		1	R: fxd prec met flm 576Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R12	0757-0474			R: fxd met flm 243 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R13	0757-0434			R: fxd prec met flm 3.65 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R14	0698-4396		1	R: fxd prec met flm 80.6Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R15	0698-4121			R: fxd prec met flm 11.3 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R16	0757-0428		1	R: fxd prec met flm 1.62 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R17	0757-0808		1	R: fxd prec met flm 301Ω ±1% 1/2 W	75042	CEC T-O obd
A2R18	0698-3557			R: fxd prec met flm 806Ω ±1% 1/8 W	75042	CEA T-O obd
A2R19				Not assigned		
A2R20	0757-0794		2	R: fxd prec met flm 68.1Ω ±1% 1/2 W	91637	MFF-1/2 T-O obd
A2R21	0698-4196			R: fxd prec met flm 1.07 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R22, A2R23	0757-0434			R: fxd prec met flm 3.65 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R24	0757-0290		2	R: fxd prec met flm 6.19 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R25	0698-4121			R: fxd prec met flm 11.3 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R26	0757-0447		1	R: fxd prec met flm 16.2 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R27	0698-3155		1	R: fxd prec met flm 4.64 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R28, A2R29	0757-0434			R: fxd prec met flm 3.65 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R30	0698-3156		4	R: fxd prec met flm 14.7 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R31	0757-0794			R: fxd prec met flm 68.1Ω ±1% 1/2 W	91637	MFF-1/2 T-O obd
A2R32	0698-4196			R: fxd prec met flm 1.07 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R33	0757-0274			R: fxd prec met flm 1.21 kΩ ±1% 1/8 W	91637	MF-1/10-32
A2R34	0757-0408			R: fxd met flm 243Ω ±1% 1/8 W	75042	CEA T-O obd
A2R35, A2R36	0757-0434			R: fxd prec met flm 3.65 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R37	0757-0438		1	R: fxd prec met flm 5.11 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R38	0698-3156			R: fxd prec met flm 14.7 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R39	0757-0422			R: fxd prec met flm 909 Ω ±1% 1/8 W	91637	MF-1/10-32
A2R40	0698-4448		2	R: fxd prec met flm 294 Ω ±1% 1/8 W	19701	MF4C
A2R41	0698-4196			R: fxd prec met flm 1.07 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R42	0757-0401			R: fxd prec met flm 100Ω ±1% 1/8 W	75042	CEA T-O obd
A2R43	0757-0408		1	R: fxd prec met flm 243Ω ±1% 1/8 W	75042	CEA T-O obd
A2R44	0698-3156			R: fxd prec met flm 14.7 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R45	0757-0277		2	R: fxd prec met flm 49.9Ω ±1% 1/8 W	91637	MFF-1/2 T-2
A2R46	0757-0441		1	R: fxd prec met flm 8.25 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R47	0698-3157		2	R: fxd prec met flm 19.6 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R48	0757-0401			R: fxd prec met flm 100Ω ±1% 1/8 W	75042	CEA T-O obd
A2R49	0698-3156			R: fxd prec met flm 14.7 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R50	0757-0434			R: fxd prec met flm 3.65 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R51	0698-4121			R: fxd met flm 11.3 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R52	0757-0444		1	R: fxd prec met flm 12.1 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R53	0698-4121			R: fxd met flm 11.3 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R54	0757-0401			R: fxd prec met flm 100Ω ±1% 1/8 W	75042	CEA T-O obd
A2R55	0698-3438			R: fxd prec met flm 147Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R56	0698-3450		2	R: fxd prec met flm 42.2 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R57	0757-0408		1	R: fxd prec met flm 243Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R58, A2R59	2100-0290		3	R: var p ec ww 100Ω ±2% 1-1/2 W	11237	110 obd
A2R60	0698-0277			R: fxd prec met flm 49.9Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R61	0698-3157			R: fxd prec met flm 19.6 kΩ ±1% 1/8 W	75042	CEA T-O obd
A2R62	2100-0290			R: var ww 100Ω ±20% 1-1/2 W	11237	110 obd
A2R63*	0698-4458		1	R: fxd prec met flm 590 Ω ±1% 1/8 W	91637	MF-1/10-32
A2R64	0698-3434		1	R: fxd prec met flm 34.8Ω ±1% 1/8 W	75042	CEA T-O obd
A2R65	0757-0381		1	R: fxd prec met flm 15Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R66	0757-0384		1	R: fxd prec met flm 20Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.
A2R67	0757-0346			R: fxd prec met flm 10 Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R68	2100-0277		1	R: var comp lin 100 Ω ±2% 0.3 W	71450	Type UPE65 CV
A2R69	0698-4196			R: fxd prec met flm 1.07 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R70	0698-3450			R: fxd prec met flm 42.2 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R71	0757-0290			R: fxd prec met flm 6.19 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R72	0698-3178			R: fxd prec met flm 487 Ω ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R73	0757-0474			R: fxd prec met flm 243 kΩ ±1% 1/8 W	91637	MFF-1/8 T-O obd
A2R74, A2R75	0757-0434		2	R: fxd prec met flm 3.65 kΩ ±1% 1/8 W (400FL only, A2R75)	91637	MFF-1/8 T-O obd
C1	0180-0106			C: fxd Ta 60 μF ±20% 6 vdcw (400FL only)	56289	150D606X006B2
CR1	1901-0040			Diode: Si (400F only) 30 mA at +10 piv 12 pF 2 ns	07910	CD6319 obd
DS1	1450-0048		2	Lamp: pilot A165 red transparent	72765	599-124
F1	2110-0017		1	Fuse: 0.15 amp slow-blow 115/230 V	75915	313.150
J1 through J3				See MP3, MP4, MP12, and MP13		
J4	1251-2357		1	Connector: ac power cord receptacle	87930	H-1061-2
L1, L2	9140-0041		2	Inductor: fxd 2.5 mH ±10%	95265	SA-2500-I
M1	1120-0918		1	Meter: linear (400F only)	-hp-	
M1	1120-0919		1	Meter: log (400FL only)	-hp-	
M1	1120-1273		1	Meter: linear (400F only, Option 01)	-hp-	
MP1	0340-0090		1	Insulator: 2 hole BP with locating key	-hp-	
MP2	0340-0086		1	Insulator: 2 hole without locating key	-hp-	
MP3	1510-0010		3	Binding Post Ass'y: red battery voltage	-hp-	
MP4	1510-0011		2	Binding Post Ass'y: black rear panel	-hp-	
MP5	1400-0084		1	Holder: fuse	75915	342014
MP6	0340-0087		1	Insulator: 3 hole BP in line	-hp-	
MP7	0340-0091		1	Insulator: 3 hole BP with locating key	-hp-	
MP8	1205-0033		2	Semiconductor: heat dissipator	05820	NF-207
MP9	00400-00605		1	Shield: meter	-hp-	
MP10	0370-0113		1	Knob: bar with one arrow part of S1 black	-hp-	
MP11	0370-0115		1	Knob: bar red with pointer part of S2	-hp-	
MP12	1510-0035		1	Binding Post Ass'y: black INPUT	-hp-	
MP13	1510-0036		1	Binding Post Ass'y: red INPUT	-hp-	
MP14	0340-0099		2	Insulator: binding post (single)	-hp-	
MP15	0340-0100		1	Insulator: binding post (single)		
MP16	5040-4503		6	Insulator: nylon threaded	-hp-	
MP17	00400-05502		1	Can: shield	-hp-	
MP18	00400-04102		1	Cover: attenuator	-hp-	
MP19	1440-0050		2	Plate: handle plated steel	12136	obd
MP20	1440-0049		2	Cap: handle, brushed cadmium	12136	obd
MP21	1440-0048		1	Strap: handle, black vinyl	12136	obd
MP22	5060-6020		1	Cover Ass'y: top 5 x 11 sm	-hp-	
MP23	5060-0703		2	Frame: sub mod 6 x 11	-hp-	
MP24	00400-00210		1	Panel: rear	-hp-	
MP25	5000-0703		2	Cover Ass'y: side 6 x 11 sm	-hp-	
MP26	5000-0711		1	Cover Ass'y: bottom 5 x 11 sm	-hp-	
MP27	1490-0031		1	Stand: 1/3 mod tilt	91260	obd
MP28	5060-0727		2	Foot Ass'y: 1/3 mod	-hp-	
MP29	5040-0700		2	Hinge	-hp-	
MP30	00400-00207		1	Panel: front (400FL only)	-hp-	
	00400-00208		1	Panel: front (400F only)	-hp-	
MP31	5020-0704		1	Trim: meter third mod (400FL only)	-hp-	
	5020-5388		1	Trim: meter third mod (400F only)	-hp-	
MP32	5060-0703		2	Frame: sub mod 6 x 11	-hp-	

Table 7-1. Replaceable Parts (Cont'd)

REFERENCE DESIGNATOR	-hp- PART NO.		TQ	DESCRIPTION	MFR.	MFR. PART NO.	
R1	0687-3331		1	R: fxd comp 33 kΩ ±10% 1/2 W	01121	EB-3331	
S1	00400-61903		1	Switch Assembly: range includes C1 CR1, CR2 R1 through R15	-hp-		
S1C1	0160-0207		1	C: fxd mylar 0.01 μF ±5% 200 V	56289	192P10352	
S1CR1, S1CR2	1901-0040			Diode: Si 30 mA at +10 V piv 12 pF 2 ns	07910	CD6319	obd
S1R1	0757-0167		1	R: fxd prec met flm 143 Ω ±1% 1/4 W	19701	MF6C T-O	obd
S1R2 through S1R6	0698-4118		5	R: fxd prec met flm 277.48 Ω ±0.1% 1/4 W	75042	CEB T-3	obd
S1R7 through S1R12	0698-4119		6	R: fxd prec met flm 410.26 Ω ±0.1% 1/4 W	75042	CEB T-3	obd
S1R13	0698-4117		1	R: fxd prec met flm 189.72 Ω ±0.1% 1/4 W	75042	CEB T-3	obd
S1R14, S1R15	0687-1501		2	R: fxd comp 15 Ω ±10% 1/2 W	-hp-		
S2				P/o RANGE switch assembly S1			
S3	3101-0036		1	Switch: toggle SPST On-None-Off 3 amps 25 V	88140	8928K61	
S4	3101-0033		1	Switch: slide DPDT 115/230 V	42190	4633	obd
T1	00400-86901		1	Transformer	-hp-		
TP1 through TP4	0360-0435		4	Terminal: board silver plated brass	12284	1012-3	
W1	00400-61602		1	Cable 1: power	-hp-		
W2	00400-61603		1	Cable 2: meter	-hp-		
	8120-1348		1	Cord: power	70903		obd

CODE LIST OF MANUFACTURERS

The following code numbers are from the Federal Supply Code for Manufacturers Cataloging Handbooks H4-1 (Name to Code) and H4-2 (Code to Name) and their latest supplements. The date of revision and the date of the supplements used appear at the bottom of each page. Alphabetical codes have been arbitrarily assigned to suppliers not appearing in the H4 Handbooks.

Code No.	Manufacturer	Address
00000	U.S.A. Common	Any supplier of U.S.
00136	McCoy Electronics	Mount Holly Springs, Pa.
00213	Sage Electronics Corp.	Rochester, N.Y.
00287	Cemco Inc.	Danielson, Conn.
00334	Humidial	Colton, Calif.
00348	Microtron Co., Inc.	Valley Stream, N.Y.
00373	Garlock Inc.	Cherry Hill, N.J.
00656	Aerovox Corp.	New Bedford, Mass.
00779	Amp. Inc.	Harrisburg, Pa.
00781	Aircraft Radio Corp.	Boonton, N.J.
00815	Northern Engineering Laboratories, Inc.	Burlington, Wis.
00853	Sangamo Electric Co., Pickens Div.	Pickens, S.C.
00866	Goe Engineering Co.	City of Industry, Cal.
00891	Carl E. Holmes Corp.	Los Angeles, Calif.
00929	Microlab Inc.	Livingston, N.J.
01002	General Electric Co., Capacitor Dept.	Hudson Falls, N.Y.
01009	Alden Products Co.	Brockton, Mass.
01121	Allen Bradley Co.	Milwaukee, Wis.
01255	Litton Industries, Inc.	Beverly Hills, Calif.
01281	TRW Semiconductors, Inc.	Lawndale, Calif.
01295	Texas Instruments, Inc., Transistor Products Div.	Dallas, Texas
01349	The Alliance Mfg. Co.	Alliance, Ohio
01589	Pacific Relays, Inc.	Van Nuys, Calif.
01670	Gudebrod Bros. Silk Co.	New York, N.Y.
01930	Amerock Corp.	Rockford, Ill.
01961	Pulse Engineering Co.	Santa Clara, Calif.
02114	Ferroxcube Corp. of America	Saugerties, N.Y.
02116	Wheelock Signals, Inc.	Long Branch, N.J.
02286	Cole Rubber and Plastics Inc.	Sunnyvale, Calif.
02660	Amphenol-Borg Electronics Corp.	Broadview, Ill.
02735	Radio Corp. of America, Semiconductor and Materials Div.	Somerville, N.J.
02771	Vocaline Co. of America, Inc.	Old Saybrook, Conn.
02777	Hopkins Engineering Co.	San Fernando, Calif.
02875	Hudson Tool & Die Co.	Newark, N.J.
03508	G.E. Semiconductor Prod. Dept.	Syracuse, N.Y.
03705	Apex Machine & Tool Co.	Dayton, Ohio
03797	Eldema Corp.	Compton, Calif.
03818	Parker Seal Co.	Los Angeles, Calif.
03877	Transitron Electric Corp.	Wakefield, Mass.
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls, N.J.
03954	Singer Co., Diehl Div. Finderne Plant	Sumerville, N.J.
04009	Arrow, Hart and Hegeman Elect. Co.	Hartford, Conn.
04013	Taurus Corp.	Lambertville, N.J.
04062	Arco Electronic Inc.	Great Neck, N.Y.
04222	Hi-Q Division of Aerovox	Myrtle Beach, S.C.
04354	Precision Paper Tube Co.	Wheeling, Ill.
04404	Dymec Division of Hewlett-Packard Co.	Palo Alto, Calif.
04651	Sylvania Electric Products, Microwave Device Div.	Mountain View, Calif.
04673	Dakota Engr. Inc.	Culver City, Calif.
04713	Motorola, Inc., Semiconductor Prod. Div.	Phoenix, Arizona
04732	Filtron Co., Inc. Western Div.	Culver City, Calif.
04773	Automatic Electric Co.	Northlake, Ill.
04796	Sequoia Wire Co.	Redwood City, Calif.
04811	Precision Coil Spring Co.	El Monte, Calif.
04870	P.M. Motor Company	Westchester, Ill.
04919	Component Mfg. Service Co.	W. Bridgewater, Mass.
05006	Twentieth Century Plastics, Inc.	Los Angeles, Calif.
05245	Components Corp.	Chicago, Ill.
05277	Westinghouse Electric Corp. Semi-Conductor Dept.	Youngwood, Pa.
05347	Ultronix, Inc.	San Mateo, Calif.
05397	Union Carbide Corp., Elect. Div.	New York, N.Y.
05574	Viking Ind. Inc.	Canoga Park, Calif.
05593	Icore Electro-Plastics Inc.	Sunnyvale, Calif.
05616	Cosmo Plastic (c/o Electrical Spec. Co.)	Cleveland, Ohio
05624	Barber Colman Co.	Rockford, Ill.
05728	Tiffen Optical Co.	Roslyn Heights, Long Island, N.Y.
05729	Metro-Tel Corp.	Westbury, N.Y.
05783	Stewart Engineering Co.	Santa Cruz, Calif.
05820	Wakefield Engineering Inc.	Wakefield, Mass.
06004	Bassick Co., Div. of Stewart Warner Corp.	Bridgeport, Conn.
06090	Raychem Corp.	Redwood City, Calif.
06175	Bausch and Lomb Optical Co.	Rochester, N.Y.
06402	E.T.A. Products Co. of America	Chicago, Ill.
06540	Amatom Electronic Hardware Co., Inc.	New Rochelle, N.Y.
06555	Beede Electrical Instrument Co., Inc.	Penacook, N.H.
06666	General Devices Co., Inc.	Indianapolis, Ind.
06751	Components Inc., Ariz. Div.	Phoenix, Ariz.
06812	Torrington Mfg. Co., West Div.	Van Nuys, Calif.
06980	Varian Assoc. Eimac Div.	San Carlos, Calif.
07088	Kelvin Electric Co.	Van Nuys, Calif.
07126	Digitran Co.	Pasadena, Calif.
07137	Transistor Electronics Corp.	Minneapolis, Minn.
07138	Westinghouse Electric Corp. Electronic Tube Div.	Elmira, N.Y.
07149	Filmohm Corp.	New York, N.Y.
07233	Cinch-Graphik Co.	City of Industry, Calif.
07256	Silicon Transistor Corp.	Carle Place, N.Y.
07261	Avnet Corp.	Culver City, Calif.
07263	Fairchild Camera & Inst. Corp. Semiconductor Div.	Mountain View, Calif.
07322	Minnesota Rubber Co.	Minneapolis, Minn.
07387	Birtcher Corp., The	Monterey Park, Calif.
07397	Sylvania Elect. Prod. Inc., Mt. View Operations	Mountain View, Calif.
07700	Technical Wire Products Inc.	Cranford, N.J.
07829	Bodine Elect. Co.	Chicago, Ill.
07910	Continental Device Corp.	Hawthorne, Calif.
07933	Raytheon Mfg. Co., Semiconductor Div.	Mountain View, Calif.
07980	Hewlett-Packard Co., Boonton Radio Div.	Rockaway, N.J.
08145	U.S. Engineering Co.	Los Angeles, Calif.
08289	Blinn, Delbert Co.	Pomona, Calif.
08358	Burgess Battery Co.	Niagara Falls, Ontario, Canada
08524	Deutsch Fastener Corp.	Los Angeles, Calif.
08664	Bristol Co., The	Waterbury, Conn.
08717	Sloan Company	Sun Valley, Calif.
08718	ITT Cannon Electric Inc., Phoenix Div.	Phoenix, Arizona
08727	National Radio Lab. Inc.	Paramus, N.J.
08792	CBS Electronics Semiconductor Operations, Div of C.B.S. Inc.	Lowell, Mass.
08806	Ceneral Electric Co. Miniat. Lamp Dept.	Cleveland, Ohio
08984	Mel-Rain	Indianapolis, Ind.
09026	Babcock Relays Div.	Costa Mesa, Calif.
09134	Texas Capacitor Co.	Houston, Texas
09145	Tech. Ind. Inc. Atohm Elect.	Burbank, Calif.
09250	Electro Assemblies, Inc.	Chicago, Ill.
09353	C & K Components Inc.	Newton, Mass.
09569	Mallory Battery Co. of Canada, Ltd.	Toronto, Ontario, Canada
09922	Burndy Corp.	Norwalk, Conn.
10214	General Transistor Western Corp.	Los Angeles, Calif.
10411	Ti-Tal, Inc.	Berkeley, Calif.
10646	Carborundum Co.	Niagara Falls, N.Y.
11236	CTS of Berne, Inc.	Berne, Ind.
11237	Chicago Telephone of California, Inc.	So. Pasadena, Calif.
11242	Bay State Electronics Corp.	Waltham, Mass.
11312	Teledyne Inc., Microwave Div.	Palo Alto, Calif.
11314	National Seal	Downey, Calif.
11453	Precision Connector Corp.	Jamaica, N.Y.
11534	Duncan Electronics Inc.	Costa Mesa, Calif.
11711	General Instrument Corp., Semiconductor Div., Products Group	Newark, N.J.
11717	Imperial Electronic, Inc.	Buena Park, Calif.
11870	Melabs, Inc.	Palo Alto, Calif.
12040	National Semiconductor	Danbury, Conn.
12136	Philadelphia Handle Co.	Camden, N.J.
12361	Grove Mfg. Co., Inc.	Shady Grove, Pa.
12574	Gulton Ind. Inc. Data System Div.	Albuquerque, N.M.
12697	Clarostat Mfg. Co.	Dover, N.H.
12728	Elmar Filter Corp.	W. Haven, Conn.
12859	Nippon Electric Co., Ltd.	Tokyo, Japan
12881	Metex Electronics Corp.	Clark, N.J.
12930	Delta Semiconductor Inc.	Newport Beach, Calif.
12954	Dickson Electronics Corp.	Scottsdale, Arizona
13103	Thermolloy	Dallas, Texas
13396	Telefunken (GmbH)	Hanover, Germany
13835	Midland-Wright Div. of Pacific Industries, Inc.	Kansas City, Kansas
14099	Sem-Tech	Newbury Park, Calif.
14193	Calif. Resistor Corp.	Santa Monica, Calif.
14298	American Components, Inc.	Conshohocken, Pa.
14433	ITT Semiconductor, A Div. of Int. Telephone & Telegraph Corp.	West Palm Beach, Fla.
14493	Hewlett-Packard Company	Loveland, Colo.
14655	Cornell Dubilier Electric Corp.	Newark, N.J.
14674	Corning Glass Works	Corning, N.Y.
14752	Electro Cube Inc.	San Gabriel, Calif.
14960	Williams Mfg. Co.	San Jose, Calif.
15203	Webster Electronics Co.	New York, N.Y.
15287	Scionics Corp.	Northridge, Calif.
15291	Adjustable Bushing Co.	N. Hollywood, Calif.
15558	Micron Electronics	Garden City, Long Island, N.Y.
15566	Amprobe Inst. Corp.	Lynbrook, N.Y.
15631	Cabletronics	Costa Mesa, Calif.
15772	Twentieth Century Coil Spring Co.	Santa Clara, Calif.
15801	Fenwal Elect. Inc.	Framingham, Mass.
15818	Amelco Inc.	Mt. View, Calif.
16037	Spruce Pine Mica Co.	Spruce Pine, N.C.
16179	Omni-Spectra Inc.	Farmington, Mich.
16352	Computer Diode Corp.	Lodi, N.J.
16585	Boots Aircraft Nut Corp.	Pasadena, Calif.
16688	Ideal Prec. Meter Co., Inc. De Jur Meter Div.	Brooklyn, N.Y.
16758	Delco Radio Div. of G.M. Corp.	Kokoma, Ind.
17109	Thermonetics Inc.	Canoga Park, Calif.
17474	Tranex Company	Mountain View, Calif.
17554	Components Inc.	Biddeford, Me.
17675	Hamlin Metal Products Corp.	Akron, Ohio
17745	Angstrohm Prec. Inc.	No. Hollywood, Calif.
17870	McGraw-Edison Co.	Manchester, N.H.
18042	Power Design Pacific Inc.	Palo Alto, Calif.
18083	Clevite Corp., Semiconductor Div.	Palo Alto, Calif.
18324	Signetics Corp.	Sunnyvale, Calif.
18476	Ty-Car Mfg. Co., Inc.	Holliston, Mass.
18486	TRW Elect. Comp. Div.	Des Plaines, Ill.
18583	Curtis Instrument, Inc.	Mt. Kisco, N.Y.
18612	Vishay Instruments Inc.	Malvern, Pa.
18873	E.I. DuPont and Co., Inc.	Wilmington, Del.
18911	Durant Mfg. Co.	Milwaukee, Wis.
19315	The Bendix Corp., Navigation & Control Div.	Teterboro, N.J.
19500	Thomas A. Edison Industries, Div. of McGraw-Edison Co.	West Orange, N.J.
19589	Concoa	Baldwin Park, Calif.
19644	LRC Electronics	Horseheads, N.Y.
19701	Electra Mfg. Co.	Independence, Kansas
20183	General Atronics Corp.	Philadelphia, Pa.
21226	Executone, Inc.	Long Island City, N.Y.
21335	Fafnir Bearing Co., The	New Britain, Conn.
21520	Fansteel Metallurgical Corp.	N. Chicago, Ill.
23042	Texscan Corp.	Indianapolis, Ind.
23783	British Radio Electronics Ltd.	Washington, D.C.
24455	G.E. Lamp Division	Nela Park, Cleveland, Ohio

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
24655	General Radio Co.	West Concord, Mass.
24681	Memcor Inc., Comp. Div.	Huntington, Ind.
24796	Parelco Inc.	San Juan Capistrano, Calif.
26365	Gries Reproducer Corp.	New Rochelle, N.Y.
26462	Grobet File Co. of America, Inc.	Carlstadt, N.J.
26851	Compac/Hollister Co.	Hollister, Calif.
26992	Hamilton Watch Co.	Lancaster, Pa.
27251	Specialities Mfg. Co., Inc.	Stratford, Conn.
28480	Hewlett-Packard Co.	Palo Alto, Calif.
28520	Heyman Mfg. Co.	Kenilworth, N.J.
30817	Instrument Specialties Co., Inc.	Little Falls, N.J.
33173	G.E. Receiving Tube Dept.	Owensboro, Ky.
35434	Lectrohm Inc.	Chicago, Ill.
36196	Stanwyck Coil Products Ltd.	Hawkesbury, Ontario, Canada
36287	Cunningham, W.H. & Hill, Ltd.	Toronto Ontario, Canada
37942	P.R. Mallory & Co. Inc.	Indianapolis, Ind.
39543	Mechanical Industries Prod. Co.	Akron, Ohio
40920	Miniature Precision Bearings, Inc.	Keene, N.H.
42190	Muter Co.	Chicago, Ill.
43990	C.A. Norgren Co.	Englewood, Colo.
44655	Ohmite Mfg. Co.	Skokie, Ill.
46384	Penn Eng. & Mfg. Corp.	Doylestown, Pa.
47904	Polaroid Corp.	Cambridge, Mass.
48620	Precision Thermometer & Inst. Co.	Southampton, Pa.
49956	Microwave & Power Tube Div.	Waltham, Mass.
52090	Rowan Controller Co.	Westminster, Md.
52983	Sanborn Company	Waltham, Mass.
54294	Shallcross Mfg. Co.	Selma, N.C.
55026	Simpson Electric Co.	Chicago, Ill.
55933	Sonotone Corp.	Elmsford, N.Y.
55938	Raytheon Co. Commercial Apparatus & Systems Div.	So. Norwalk, Conn.
56137	Spaulding Fibre Co., Inc.	Tonawanda, N.Y.
56289	Sprague Electric Co.	North Adams, Mass.
59446	Telex Corp.	Tulsa, Okla.
59730	Thomas & Betts Co.	Elizabeth, N.J.
60741	Triplett Electrical Inst. Co.	Bluffton, Ohio
61775	Union Switch and Signal, Div. of Westinghouse Air Brake Co.	Pittsburgh, Pa.
62119	Universal Electric Co.	Owosso, Mich.
63743	Ward-Leonard Electric Co.	Mt. Vernon, N.Y.
64959	Western Electric Co., Inc.	New York, N.Y.
65092	Weston Inst. Inc. Weston-Newark	Newark, N.J.
66295	Wittek Mfg. Co.	Chicago, Ill.
66346	Minnesota Mining & Mfg. Co. Revere Mincom Div.	St. Paul, Minn.
70276	Allen Mfg. Co.	Hartford, Conn.
70309	Allied Control	New York, N.Y.
70318	Allmetal Screw Product Co., Inc.	Garden City, N.Y.
70417	Amplex, Div. of Chrysler Corp.	Detroit, Mich.
70485	Atlantic India Rubber Works, Inc.	Chicago, Ill.
70563	Amperite Co., Inc.	Union City, N.J.
70674	ADC Products Inc.	Minneapolis, Minn.
70903	Belden Mfg. Co.	Chicago, Ill.
70998	Bird Electronic Corp.	Cleveland, Ohio
71002	Birnbach Radio Co.	New York, N.Y.
71034	Bliley Electric Co., Inc.	Erie, Pa.
71041	Boston Gear Works Div. of Murray Co. of Texas	Quincy, Mass.
71218	Bud Radio, Inc.	Willoughby, Ohio
71279	Cambridge Thermionics Corp.	Cambridge, Mass.
71286	Camloc Fastener Corp.	Paramus, N.J.
71313	Cardwell Condenser Corp.	Lindenhurst L.I., N.Y.
71400	Bussmann Mfg. Div. of McGraw-Edison Co.	St. Louis, Mo.
71436	Chicago Condenser Corp.	Chicago, Ill.
71447	Calif. Spring Co., Inc.	Pico-Rivera, Calif.
71450	CTS Corp.	Elkhart, Ind.
71468	ITT Cannon Electric Inc.	Los Angeles, Calif.
71471	Cinema, Div. Aerovox Corp.	Burbank, Calif.
71482	C.P. Clare & Co.	Chicago, Ill.
71590	Centralab Div. of Globe Union Inc.	Milwaukee, Wis.
71616	Commercial Plastics Co.	Chicago, Ill.
71700	Cornish Wire Co., The	New York, N.Y.
71707	Coto Coil Co., Inc.	Providence, R.I.

Code No.	Manufacturer	Address
71744	Chicago Miniature Lamp Works	Chicago, Ill.
71785	Cinch Mfg. Co., Howard B. Jones Div.	Chicago, Ill.
71984	Dow Corning Corp.	Midland, Mich.
72136	Electro Motive Mfg. Co., Inc.	Willimantic, Conn.
72619	Dialight Corp.	Brooklyn, N.Y.
72656	Indiana General Corp., Electronics Div.	Keasby, N.J.
72699	General Instrument Corp., Cap. Div.	Newark, N.J.
72765	Drake Mfg. Co.	Harwood Heights, Ill.
72825	Hugh H. Eby Inc.	Philadelphia, Pa.
72928	Gudeman Co.	Chicago, Ill.
72962	Elastic Stop Nut Corp.	Union, N.J.
72964	Robert M. Hadley Co.	Los Angeles, Calif.
72982	Erie Technological Products, Inc.	Erie, Pa.
73061	Hansen Mfg. Co., Inc.	Princeton, Ind.
73076	H.M. Harper Co.	Chicago, Ill.
73138	Helipot Div. of Beckman Inst., Inc.	Fullerton, Calif.
73293	Hughes Products Division of Hughes Aircraft Co.	Newport Beach, Calif.
73445	Amperex Elect Co.	Hicksville, L.I., N.Y.
73506	Bradley Semiconductor Corp.	New Haven, Conn.
73559	Carling Electric, Inc.	Hartford, Conn.
73586	Circle F Mfg. Co.	Trenton, N.J.
73682	George K. Garrett Co., Div. MSL Industries Inc.	Philadelphia, Pa.
73734	Federal Screw Products Inc.	Chicago, Ill.
73743	Fischer Special Mfg. Co.	Cincinnati, Ohio
73793	General Industries Co., The	Elyria, Ohio
73846	Goshen Stamping & Tool Co.	Goshen, Ind.
73899	JFD Electronics Corp.	Brooklyn, N.Y.
73905	Jennings Radio Mfg. Corp.	San Jose, Calif.
73957	Groov-Pin Corp.	Ridgefield, N.J.
74276	Signalite Inc.	Neptune, N.J.
74455	J.H. Winns, and Sons	Winchester, Mass.
74861	Industrial Condenser Corp.	Chicago, Ill.
74868	R.F. Products Division of Amphenol-Borg Electronics Corp.	Danbury, Conn.
74970	E.F. Johnson Co.	Waseca, Minn.
75042	International Resistance Co.	Philadelphia, Pa.
75263	Keystone Carbon Co., Inc.	St. Marys, Pa.
75378	CTS Knights Inc.	Sandwich, Ill.
75382	Kulka Electric Corporation	Mt. Vernon, N.Y.
75818	Lenz Electric Mfg. Co.	Chicago, Ill.
75915	Littlefuse, Inc.	Des Plaines, Ill.
76005	Lord Mfg. Co.	Erie, Pa.
76210	C.W. Marwedel	San Francisco, Calif.
76433	General Instrument Corp., Micamold Division	Newark, N.J.
76487	James Millen Mfg. Co., Inc.	Malden, Mass.
76493	J.W. Miller Co.	Los Angeles, Calif.
76530	Cinch-Monadnock, Div. of United Carr Fastener Corp.	San Leandro, Calif.
76545	Mueller Electric Co.	Cleveland, Ohio
76703	National Union	Newark, N.J.
76854	Oak Manufacturing Co.	Crystal Lake, Ill.
77068	The Bendix Corp., Electrodynamics Div.	N. Hollywood, Calif.
77075	Pacific Metals Co.	San Francisco, Calif.
77221	Phanostran Instrument and Electronic Co.	South Pasadena, Calif.
77252	Philadelphia Steel and Wire Corp.	Philadelphia, Pa.
77342	American Machine & Foundry Co. Potter & Brumfield Div.	Princeton, Ind.
77630	TRW Electronic Components Div.	Camden, N.J.
77638	General Instrument Corp., Rectifier Div.	Brooklyn, N.Y.
77764	Resistance Products Co.	Harrisburg, Pa.
77969	Rubbercraft Corp. of Calif.	Torrance, Calif.
78189	Shakeproof Division of Illinois Tool Works	Elgin, Ill.
78277	Sigma	So. Braintree, Mass.
78283	Signal Indicator Corp.	New York, N.Y.
78290	Struthers-Dunn Inc.	Pitman, N.J.
78424	Speciality Leather Prod. Co.	Newark, N.J.
78452	Thompson-Bremer & Co.	Chicago, Ill.
78471	Tilley Mfg. Co.	San Francisco, Calif.
78488	Stackpole Carbon Co.	St. Marys, Pa.
78493	Standard Thomson Corp.	Waltham, Mass.
78553	Tinnerman Products, Inc.	Cleveland, Ohio
78790	Transformer Engineers	San Gabriel, Calif.

Code No.	Manufacturer	Address
78947	Ucinite Co.	Newtonville, Mass.
79136	Waldes Kohinoor Inc.	Long Island City, N.Y.
79142	Veeder Root, Inc.	Hartford, Conn.
79251	Wenco Mfg. Co.	Chicago, Ill.
79727	Continental-Wirt Electronics Corp.	Philadelphia, Pa.
79963	Zierick Mfg. Corp.	New Rochelle, N.Y.
80031	Mepco Division of Sessions Clock Co.	Morristown, N.J.
80120	Schnitzer Alloy Products Co.	Elizabeth, N.J.
80131	Electronic Industries Association. Any brand Tube meeting EIA Standards-Washington, DC.	
80207	Unimax Switch, Div. Maxon Electronics Corp.	Wallingford, Conn.
80223	United Transformer Corp.	New York, N.Y.
80248	Oxford Electric Corp.	Chicago, Ill.
80294	Bourns Inc.	Riverside, Calif.
80411	Acro Div. of Robertshaw Controls Co.	Columbus, Ohio
80486	All Star Products Inc.	Defiance, Ohio
80509	Avery Label Co.	Monrovia, Calif.
80583	Hammarlund Co., Inc.	Mars Hill, N.C.
80640	Stevens, Arnold, Co., Inc.	Boston, Mass.
80813	Dimco Gray Co.	Dayton, Ohio
81030	International Instruments Inc.	Orange, Conn.
81073	Grayhill Co.	LaGrange, Ill.
81095	Triad Transformer Corp.	Venice, Calif.
81312	Winchester Elec. Div. Litton Ind., Inc.	Oakville, Conn.
81349	Military Specification	. . . . . .
81483	International Rectifier Corp.	El Segundo, Calif.
81541	Airpax Electronics, Inc.	Cambridge, Maryland
81860	Barry Controls, Div. Barry Wright Corp.	Watertown, Mass.
82042	Carter Precision Electric Co.	Skokie, Ill.
82047	Sperti Faraday Inc., Copper Hewitt Electric Div.	Hoboken, N.J.
82116	Electric Regulator Corp.	Norwalk, Conn.
82142	Jeffers Electronics Division of Speer Carbon Co.	Du Bois, Pa.
82170	Fairchild Camera & Inst. Corp. Space & Defense System Div.	Paramus, N.J.
82209	Maguire Industries, Inc.	Greenwich, Conn.
82219	Sylvania Electric Prod. Inc. Electronic Tube Division	Emporium, Pa.
82376	Astron Corp.	East Newark, Harrison, N.J.
82389	Switchcraft, Inc.	Chicago, Ill.
82647	Metals & Controls Inc. Spencer Products	Attleboro, Mass.
82768	Phillips-Advance Control Co.	Joliet, Ill.
82866	Research Products Corp.	Madison, Wis.
82877	Rotron Mfg. Co., Inc.	Woodstock, N.Y.
82893	Vector Electronic Co.	Glendale, Calif.
83014	Hartwell Corp.	Los Angeles, Calif.
83058	Carr Fastener Co.	Cambridge, Mass.
83086	New Hampshire Ball Bearing, Inc.	Peterborough, N.H.
83125	General Instrument Corp., Capacitor Div.	Darlington, S.C.
83148	ITT Wire and Cable Div.	Los Angeles, Calif.
83186	Victory Eng. Corp.	Springfield, N.J.
83298	Bendix Corp., Red Bank Div.	Red Bank, N.J.
83315	Hubbell Corp.	Mundelein, Ill.
83324	Rosan Inc.	Newport Beach, Calif.
83330	Smith, Herman H., Inc.	Brooklyn, N.Y.
83332	Tech Labs	Palisade's Park, N.J.
83385	Central Screw Co.	Chicago, Ill.
83501	Gavitt Wire and Cable Co. Div. of Amerace Corp.	Brookfield, Mass.
83594	Burroughs Corp. Electronic Tube Div.	Plainfield, N.J.
83740	Union Carbide Corp. Consumer Prod. Div.	New York, N.Y.
83777	Model Eng. and Mfg., Inc.	Huntington, Ind.
83821	Loyd Scruggs Co.	Festus, Mo.
83942	Aeronautical Inst. & Radio Co.	Lodi, N.J.
84171	Arco Electronics Inc.	Great Neck, N.Y.
84396	A.J. Glesener Co., Inc.	San Francisco, Calif.
84411	TRW Capacitor Div.	Ogallala, Neb.
84970	Sarkes Tarzian, Inc.	Bloomington, Ind.
85454	Boonton Molding Company	Boonton, N.J.
85471	A.B. Boyd Co.	San Francisco, Calif.
85474	R.M. Bracamonte & Co.	San Francisco, Calif.

CODE LIST OF MANUFACTURERS (Continued)

Code No.	Manufacturer	Address
85660	Koiled Kords, Inc.	Hamden, Conn.
85911	Seamless Rubber Co.	Chicago, Ill.
86174	Fafnir Bearing Co.	Los Angeles, Calif.
86197	Clifton Precision Products Co., Inc.	Clifton Heights, Pa.
86579	Precision Rubber Products Corp.	Dayton, Ohio
86684	Radio Corp. of America, Electronic Comp. & Devices Div.	Harrison, N.J.
86928	Seastrom Mfg. Co.	Glendale, Calif.
87034	Marco Industries	Anaheim, Calif.
87216	Philco Corporation (Lansdale Division)	Lansdale, Pa.
87473	Western Fibrous Glass Products Co.	San Francisco, Calif.
87664	Van Waters & Rogers Inc.	San Francisco, Calif.
87930	Tower Mfg. Corp.	Providence, R.I.
88140	Cutler-Hammer, Inc.	Lincoln, Ill.
88220	Gould-National Batteries, Inc.	St. Paul, Minn.
88698	General Mills, Inc.	Buffalo, N.Y.
89231	Graybar Electric Co.	Oakland, Calif.
89473	G.E. Distributing Corp.	Schenectady, N.Y.
89665	United Transformer Co.	Chicago, Ill.
90030	United Shoe Machinery Corp.	Beverly, Mass.
90179	US Rubber Co., Consumer Ind. & Plastics Prod. Div.	Passaic, N.J.
90970	Bearing Engineering Co.	San Francisco, Calif.
91146	ITT Cannon Elect, Inc., Salem Div.	Salem, Mass.
91260	Connor Spring Mfg. Co.	San Francisco, Calif.
91345	Miller Dial & Nameplate Co.	El Monte, Calif.
91418	Radio Materials Co.	Chicago, Ill.
91506	Augat Inc.	Attleboro, Mass.
91637	Dale Electronics, Inc.	Columbus, Nebr.
91662	Elco Corp.	Willow Grove, Pa.
91737	Gremar Mfg. Co., Inc.	Wakefield, Mass.
91827	K F Development Co.	Redwood City, Calif.
91886	Malco Mfg. Co., inc.	Chicago, Ill.
91929	Honeywell Inc., Micro Switch Div.	Freeport, Ill.
91961	Nahm-Bros. Spring Co.	Oakland, Calif.
92180	Tru-Connector Corp.	Peabody, Mass.
92367	Elgeet Optical Co. Inc.	Rochester, N.Y.
92607	Tensolite Insulated Wire Co., Inc.	Tarrytown, N.Y.
92702	IMC Magnetics Corp.	Wesbury Long Island, N.Y.
92966	Hudson Lamp Co.	Kearney, N.J.
93332	Sylvania Electric Prod. Inc. Semiconductor Div.	Woburn, Mass.
93369	Robbins & Myers Inc.	Palisades Park, N.J.
93410	Stemco Controls, Div. of Essex Wire Corp.	Mansfield, Ohio
93632	Waters Mfg. Co.	Culver City, Calif.
93929	G.V. Controls	Livingston, N.J.
94137	General Cable Corp.	Bayonne, N.J.
94142	Phelps Dodge	Yonkers, N.Y.
94144	Raytheon Co., Comp. Div., Ind. Comp. Operations	Quincy, Mass.
94148	Scientific Electronics Products, Inc.	Loveland, Colo.
94154	Wagner Elect. Corp., Tung-Sol Div.	Newark, N.J.
94197	Curtiss-Wright Corp. Electronics Div.	East Paterson, N.J.
94222	South Chester Corp.	Chester, Pa.
94330	Wire Cloth Products, Inc.	Bellwood, Ill.
94375	Automatic Metal Products Co.	Brooklyn, N.Y.
94682	Worcester Pressed Aluminum Corp.	Worcester, Mass.
94696	Magnecraft Electric Co.	Chicago, Ill.
95023	George A. Philbrick Researchers, Inc.	Boston, Mass.
95236	Allies Products Corp.,	Dania, Fla.
95238	Continental Connector Corp.	Woodside, N.Y.
95263	Leecraft Mfg. Co., Inc.	Long Island, N.Y.
95265	National Coil Co.	Sheridan, Wyo.
95275	Vitramon, Inc.	Bridgeport, Conn.
95348	Gordos Corp.	Bloomfield, N.J.
95354	Methode Mfg. Co.	Rolling Meadows, Ill.
95566	Arnold Engineering Co.	Marengo, Ill.
95712	Dage Electric Co., Inc.	Franklin, Ind.
95984	Siemon Mfg. Co.	Wayne, Ill.
95987	Weckesser Co.	Chicago, Ill.
96067	Microwave Assoc., West Inc.	Sunnyvale, Calif.
96095	Hi-Q Div. of Aerovox Corp.	Olean, N.Y.
96256	Thordarson-Meissner Inc.	Mt. Carmel, Ill.
96296	Solar Manufacturing Co.	Los Angeles, Calif.
96306	Microswitch, Div. of Minn.—Honeywell	Freeport, Ill.
96330	Carlton Screw Co.	Chicago, Ill.
96341	Microwave Associates, Inc.	Burlington, Mass.
96501	Excel Transformer Co.	Oakland, Calif.
96733	San Fernando Elect. Mfg. Co.	San Fernando, Calif.
96881	Thomson Ind. Inc.	Long Is., N.Y.
97464	Industrial Retaining Ring Co.	Irvington, N.J.
97539	Automatic & Precision Mfg.	Englewood, N.J.
97979	Reon Resistor Corp.	Yonkers, N.Y.
97983	Litton System Inc., Adler-Westrex Commun. Div.	New Rochelle, N.Y.
98141	R-Troncis, Inc.	Jamaica, N.Y.
98159	Rubber Teck, Inc.	Gardena, Calif.
98220	Hewlett-Packard Co., Moseley Div.	Pasadena, Calif.
98278	Microdot, Inc.	So. Pasadena, Calif.
98291	Sealectro Corp.	Mamaroneck, N.Y.
98376	Zero Mfg. Co.	Burbank, Calif.
98410	Etc Inc.	Cleveland, Ohio
98731	General Mills Inc., Electronics Div.	Minneapolis, Minn.
98734	Paeco Div. of Hewlett-Packard Co.	Palo Alto, Calif.
98821	North Hills Electronics, Inc.	Glen Cove, N.Y.
98978	International Electronic Research Corp.	Burbank, Calif.
99109	Columbia Technical Corp.	New York, N.Y.
99313	Varian Associates	Palo Alto, Calif.
99378	Atlee Corp.	Winchester, Mass.
99515	Marshall Ind., Capacitor Div.	Monrovia, Calif.
99707	Control Switch Division, Controls Co. of America	El Segundo, Calif.
99800	Delevan Electronics Corp.	East Aurora, N.Y.
99848	Wilco Corporation	Indianapolis, Ind.
99928	Branson Corp.	Whippany, N.J.
99934	Renbrandt, Inc.	Boston, Mass.
99942	Hoffman Electronics Corp. Semiconductor Div.	El Monte, Calif.
99957	Technology Instrument Corp. of Calif.	Newbury Park, Calif.

THE FOLLOWING HP VENDORS HAVE NO NUMBER ASSIGNED IN THE LATEST SUPPLEMENT TO THE FEDERAL SUPPLY CODE FOR MANUFACTURERS HANDBOOK.

Code No.	Manufacturer	Address
0000F	Malco Tool and Die	Los Angeles, Calif.
0000Z	Willow Leather Products Corp.	Newark, N.J.
000AB	ETA	England
000BB	Precision Instrument Components Co.	Van Nuys, Calif.
000CS	Hewlett-Packard Co., Colorado Springs	Colorado Springs, Colorado
000MM	Rubber Eng. & Development	Hayward, Calif.
000NN	A "N" D Mfg. Co.	San Jose, Calif.
000QQ	Cooltron	Oakland, Calif.
000WW	California Eastern Lab.	Burlington, Calif.
000YY	S.K. Smith Co.	Los Angeles, Calif.

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Kansas City 64114
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TWX: 910-771-2087

2812 South Brentwood Blvd.
St. Louis 63144
Tel: (314) 962-5000
TWX: 910-760-1670

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Paramus 07652
Tel: (201) 265-5000
TWX: 710-990-4951

1060 N. Kings Highway
Cherry Hill 08034
Tel: (609) 667-4000
TWX: 710-892-4945

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4475 S.W. Scholls Ferry Road
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1021 8th Avenue
King of Prussia Industrial Park
King of Prussia 19406
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TWX: 910-443-2303

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304-1037 West Broadway
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Hewlett-Packard (Canada) Ltd.
511 Bradford Ct.
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Tel: (204) 786-7581

NOVA SCOTIA
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880 Lady Ellen Place
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TWX: 610-562-1952

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1415 Lawrence Avenue West
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Casilla 3061
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Tel: 50346
Cable: FEPERU Lima

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Pda. 3-Pta. de Tierra
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Telex: SATRON 3450 332

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Telex: 85 86 533

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Cable: HEWPACKSA Frankfurt
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E 6/69

MANUAL BACKDATING CHANGES

MODEL 400F/FL

AC VOLTMETER

Manual Serial Prefixed: 950-
-hp- Part No. 00400-90009

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes
617-00450 and below	1, 2, 3, 4, 6
617-00451 thru 617-01525	2, 3, 4, 6
734-01526 thru 734-02775	3, 4, 6
912-02776 thru 912-02875	4, 5, 6

Instrument Serial Prefix	Make Manual Changes
912-02876 thru 912-02975	5, 6
912-02976 thru 912-03475	6

CHANGE #1 — Delete diodes A2CR24 through A2CR28 from Figure 6-2, Figure 6-3, and Table 7-1.

CHANGE #2 — Page 5-5, Paragraph 5-37b, change "+6 V" to "-6 V."

Figure 6-3:

Change PREAMPLIFIER schematic to the following:

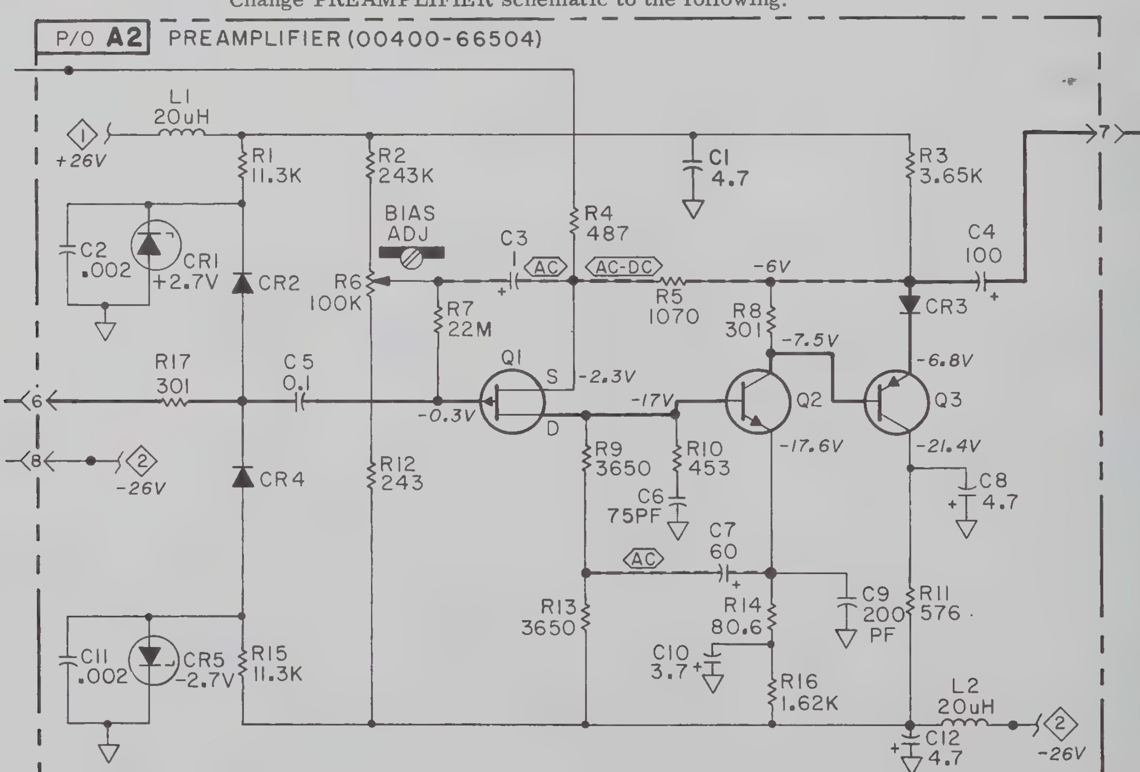
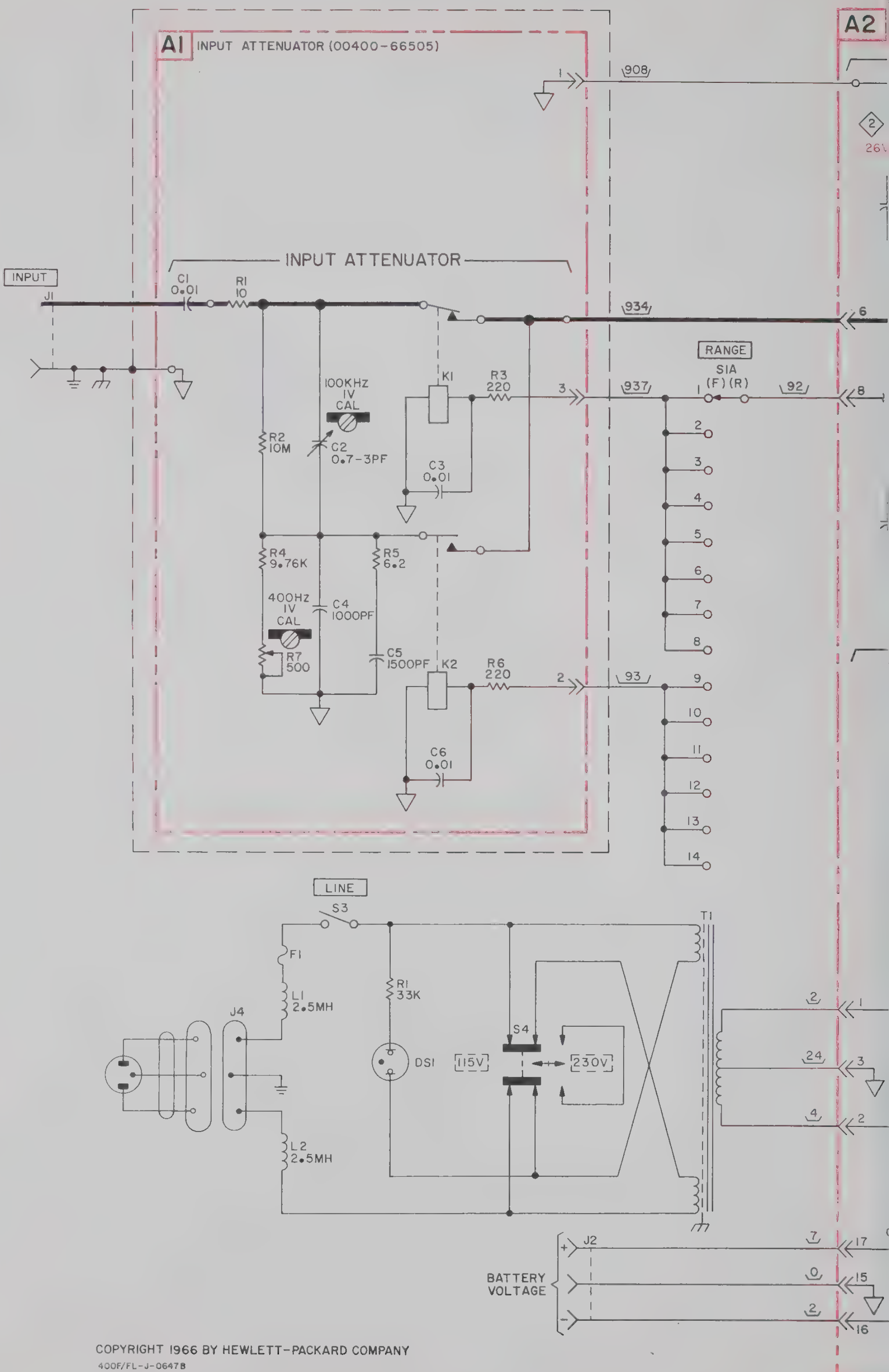


Table 7-1:

Change A2Q1 to 1855-0052 FET N channel.
Change A2Q2 to 1854-0314 Si NPN.
Change A2Q3 to 1853-0036 Si PNP.



400F/FL-J-0647B

MANUAL BACKDATING CHANGES

MODEL 400F/FL

AC VOLTMETER

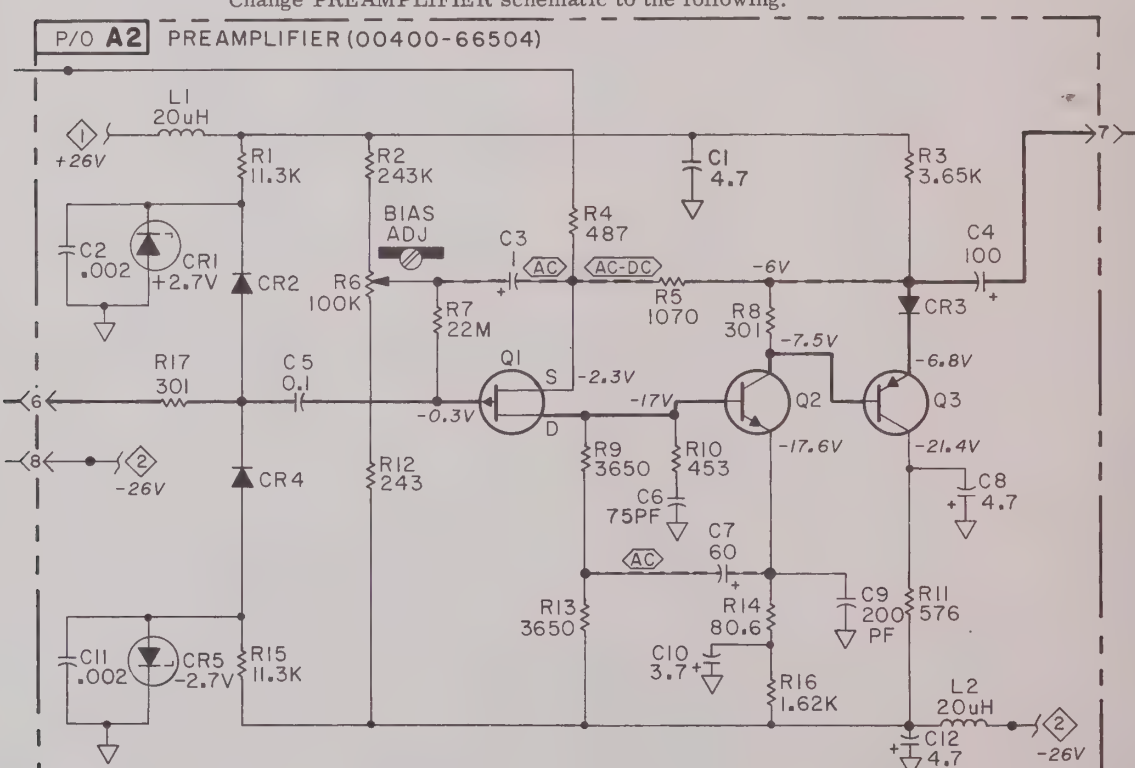
Manual Serial Prefixed: 950-
-hp- Part No. 00400-90009

This manual backdating sheet makes this manual applicable to earlier instruments. Instrument-component values that differ from those in the manual, yet are not listed in the backdating sheet, should be replaced using the part number given in the manual.

Instrument Serial Prefix	Make Manual Changes	Instrument Serial Prefix	Make Manual Changes
617-00450 and below	1, 2, 3, 4, 6	912-02876 thru 912-02975	5, 6
617-00451 thru 617-01525	2, 3, 4, 6	912-02976 thru 912-03475	6
734-01526 thru 734-02775	3, 4, 6		
912-02776 thru 912-02875	4, 5, 6		

CHANGE #1 Delete diodes A2CR24 through A2CR28 from Figure 6-2, Figure 6-3, and Table 7-1.

CHANGE #2 Page 5-5, Paragraph 5-37b, change "+6 V" to "-6 V."
Figure 6-3:
Change PREAMPLIFIER schematic to the following:



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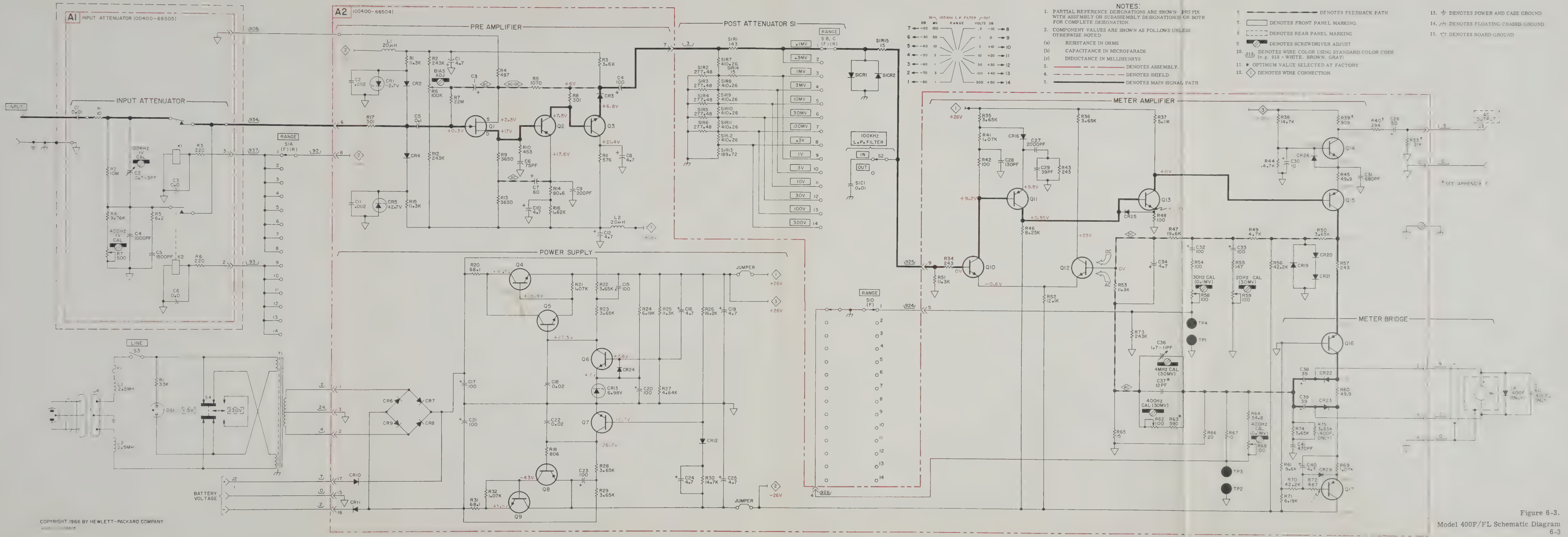


NOTES:

1. PARTIAL REFERENCE DESIGNATIONS ARE SHOWN. PREFIX WITH ASSEMBLY OR SUBASSEMBLY DESIGNATION(S) OR BOTH FOR COMPLETE DESIGNATION.
2. COMPONENT VALUES ARE SHOWN AS FOLLOWS UNLESS OTHERWISE NOTED:
   (a) RESISTANCE IN OHMS
   (b) CAPACITANCE IN MICROFARADS
   (c) INDUCTANCE IN MILLIHENRYS
3. DENOTES ASSEMBLY.
4. DENOTES SHIELD.
5. DENOTES MAIN SIGNAL PATH
6. DENOTES FEEDBACK PATH
7. DENOTES FRONT PANEL MARKING.
8. DENOTES REAR PANEL MARKING
9. DENOTES SCREWDRIVER ADJUST
10. 918 DENOTES WIRE COLOR USING STANDARD COLOR CODE (e.g. 918 = WHITE, BROWN, GRAY)
11. * OPTIMUM VALUE SELECTED AT FACTORY
12. DENOTES WIRE CONNECTION.
13. DENOTES POWER AND CASE GROUND
14. DENOTES FLOATING CHASSIS GROUND
15. DENOTES BOARD GROUND

Figure 6-3.
Model 400F/FL Schematic Diagram

EFIX
BOTH

6. ▬ ▬ ▬ DENOTES FEEDBACK PATH.

7. ▭ DENOTES FRONT PANEL MARKING.

8. [- - -] DENOTES REAR PANEL MARKING.

9. DENOTES SCREWDRIVER ADJUST.

10. 918 DENOTES WIRE COLOR USING STANDARD COLOR CODE. (e.g. 918 = WHITE, BROWN, GRAY)

11. * OPTIMUM VALUE SELECTED AT FACTORY.

12. ◇1 DENOTES WIRE CONNECTION.

13. ⏚ DENOTES POWER AND CASE GROUND

14. DENOTES FLOATING CHASSIS GROUND

15. ▽ DENOTES BOARD GROUND

ATH.

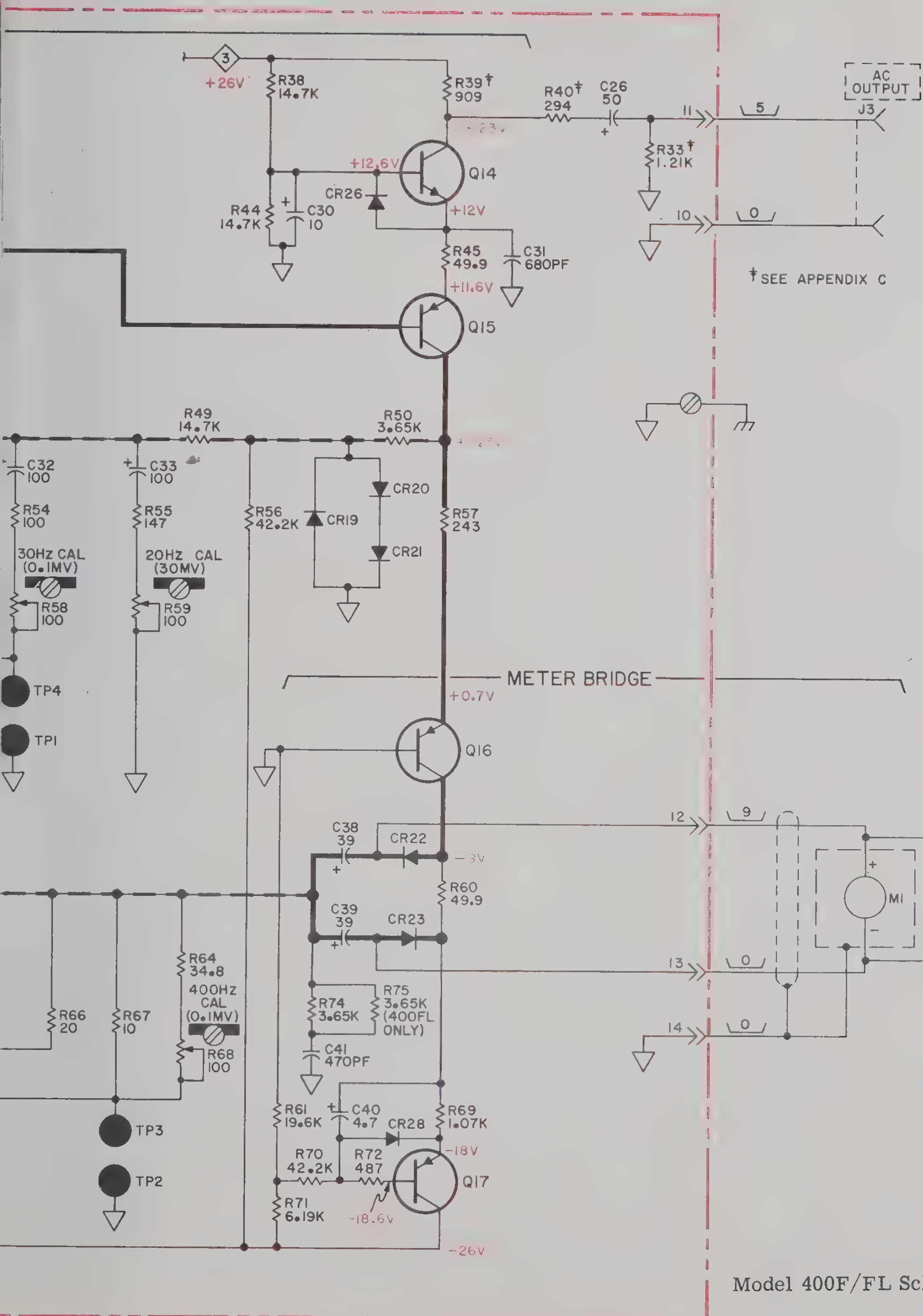


Figure 6-3.

Model 400F/FL Schematic Diagram

6-3

HEWLETT hp PACKARD

OPERATING AND SERVICE MANUAL

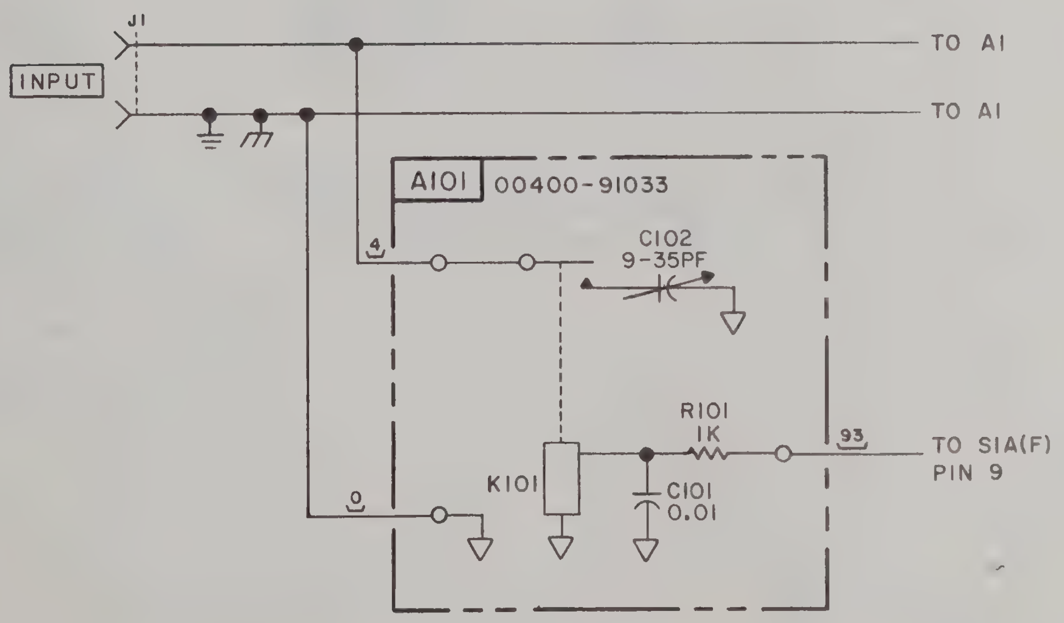
MODIFICATIONS
SPECIFICATION H10-400F/FL

AC VOLTMETER

Specification H10-400F/FL is a standard -hp- Model 400F/FL which has been modified to maintain constant input capacitance on all ranges. The input capacitance specification for the 1V through 300V ranges is increased to be the same as for the 100 μV through 300 mV ranges.

Figure 1 is a schematic of the modifications; refer also to Figure 6-3 of the 400F/FL Operating and Service Manual (-hp- Part No. 00400-90005). On the 1V through 300V ranges the relay (K101) is energized to connect the variable capacitor (C102) across the input terminals (J1). C102 is adjusted for the required input capacitance (procedure below) on the 1V through 300V ranges.

Figure 1



9-008-026

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H10-400F/FL (cont'd)

C102 Adjustment

Refer to 400F/FL Operating and Service Manual, Section V, when making this adjustment.

1) Perform Input Capacity check for the 300 mV range of H10-400F/FL using test setup and method outlined in paragraph 5-20, Input Capacity check, steps a, e, f and g; note frequency to which test oscillator is set in step g.
2) Set H10-400F/FL RANGE switch to 3V.
3) Adjust test oscillator output, at 400 Hz, for full-scale deflection of H10-400F/FL.
4) Adjust test oscillator to same frequency as noted in step 1).
5) Adjust C102 for H10-400F/FL indication of 2.12V.

Parts added to the standard instrument are:

Reference Designators	-hp- Part No.	Description
A101	00400-91033	Board: etched circuit ass'y
C101	0150-0093	Capacitor, fxd, cer 0.01 μF +80% -20% 100 vdcw
C102	0121-0105	Capacitor, var, cer 9-35 pF
K101	0490-0343	Relay, reed
R101	0683-1025	Resistor, fxd, comp 1 kΩ, ±5% 1/4 W

In all other respects this special instrument is electrically identical to the standard -hp- Model 400F/FL, and the information in the Operating and Service Manual for the standard instrument applies to this special instrument.

Enclosure: 400F/FL

BHS/September 1968

MANUAL CHANGES

MODEL 400F/FL

AC VOLTMETER

Manual Serial Prefixed: 950-
-hp- Part No. 00400-90009

► New or Revised Item

Instrument Serial Number	Make Manual Changes	Instrument Serial Number	Make Manual Changes
All Serial Numbers	ERRATA		
950-03476 and up	Change #1		
950-03576 and up	Change #2		
950-03676 and up	Change #3		

ERRATA

Page 7-3: Change A2Q1 to 1855-0033.
► Page 7-4: Change A2R63 to 0757-0277.
Page 7-5: Interchange MP20 and MP21.

CHANGE #1

Page 7-6: Rear panel 115/230 V S4 switch changed to 3101-1234.

► CHANGE #2

Page 7-5: Fuse changed to 2110-0320.

► CHANGE #3

Page 7-3: A2CR22, CR23 changed to 1901-0535. Recommended replacement on all instruments.

Manual Backdating Changes Model 400F/FL **Page 2**

CHANGE #3 Figure 6-3 and Table 7-1:

A2R33	0757-0474	R: fxd prec met flm 243 kΩ ±1% 1/8 W
A2R39	0698-3510	R: fxd prec met flm 453 Ω ±1% 1/8 W
A2R40	0698-3438	R: fxd prec met flm 147 Ω ±1% 1/8 W

CHANGE #4 Figure 6-3 and Table 7-1:

A2R63	0757-0417	R: fxd prec met flm 562 Ω ±1% 1/8 W

CHANGE #5 Figure 6-3 and Table 7-1:

A2R33	0698-4125	R: fxd prec met flm 953 Ω ±1% 1/8 W
A2R39	0698-4422	R: fxd prec met flm 1.27 kΩ ±1% 1/8 W
A2R40	0698-3488	R: fxd prec met flm 442 Ω ±1% 1/8 W

CHANGE #6 Table 7-1:

J4	1251-0148	Connector: ac power cord receptacle	87930	H-1061-2
MP24	00400-00206	Panel: rear	-hp-	
	8120-0078	Cord: power		

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